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Boswell Energy Center

Site-Specific No Alternative Disposal Capacity Demonstrations

- Pond 3
- Bottom Ash Pond

Submittal Date: November 16, 2020

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Executive Summary

Minnesota Power (MP) has two active clay-lined impoundments at the Boswell Energy Center (BEC) which are subject to closure based on the *Utility Solid Waste Activities Group v. EPA,* 901 F.3d 414 (D.C. Cir. 2018) decision ("USWAG Decision") and subsequent CCR Part A Rulemaking. MP is submitting the two No Alternative Disposal Capacity Demonstrations (Demonstrations) contained in this document under the provisions of the CCR Part A rulemaking §257.103(f)(1).

The two BEC impoundments for which MP is submitting a Demonstration are:

- Bottom Ash Pond (BAP), which receives bottom ash from BEC Units 3 and 4. The BAP also serves as a settling and equalization basin for various non-CCR wastewater streams. The fastest technically feasible cease receipt date for the BAP is June 4, 2022.

- Pond 3, which receives flue gas desulphurization (FGD) slurry from BEC Unit 3 air pollution control equipment. The fastest technically feasible cease receipt date for Pond 3 is May 6, 2022.

Post-USWAG Decision and prior to the Part A Rulemaking, MP recognized the need to take steps towards closure of the BAP and Pond 3. To that end, MP selected two CCR dewatering technologies and submitted the required air permitting application to the Minnesota Pollution Control Agency (MPCA) on April 15, 2020. Once permitted and operational, the dewatering technologies will allow BEC to cease receipt of CCR in both impoundments. BEC also conducted a detailed analysis on how to manage non-CCR wastewaters currently going to the BAP. This work allowed BEC to select a new non-CCR wastewater pond and initiate steps to incorporate the new settling and equalization pond into BEC's National Pollutant Discharge Elimination System (NPDES) permit. When complete, the non-CCR wastewater pond will allow BEC to cease receipt of non-CCR wastewaters in the BAP.

MP's evaluation of the fastest technically feasible options for ceasing receipt of CCR and non-CCR waste streams at these impoundments involved a two-tiered approach. First, alternative disposal options were evaluated for technical feasibility. Secondly, implementation schedules for the technically feasible options were developed, using a start date of the actual or projected environmental permit application submittal. Based on this approach, MP determined that a multi-technology system is the fastest technically feasible option for ceasing receipt of CCR and non-CCR waste streams at BEC's clay-lined impoundments. A summary of the selected alternatives is provided below.

> <u>Bottom Ash Pond (BAP):</u> MP determined that converting the existing wet bottom ash handling systems on Unit 3 and 4 to dry handling and storage is the fastest technically feasible option to cease receipt of CCR. MP's evaluation showed dry conversion could be accomplished more quickly than other options, primarily due to steps already taken,

shorter construction timeframes, and more expedient environmental permitting timelines compared to other alternatives. Once dry conversion technology is installed, the dewatered bottom ash will be stored in the onsite CCR landfill.

The BAP also receives non-CCR wastestreams; options for ceasing receipt of these non-CCR wastestreams are dependent on successful completion of the dry conversion projects. If the planned dry conversion projects are not feasible, then alternate wet storage options for CCR wastestreams could potentially be designed to also include non-CCR wastestreams.

Based on indications from MPCA in fall 2020 that air permitting for dry conversion projects is on track, MP determined the fastest technically feasible storage alternative for the non-CCR wastewater streams is to permit and construct a new, non-CCR wastewater settling and equalization basin. MP's evaluation showed that while retrofitting existing impoundments and installation of tanks were technically feasible, these options would take longer to implement than the selected option.

Pond 3: MP determined that converting the existing wet flue gas desulfurization (FGD) handling system to a dry handling and storage system is the fastest technically feasible option to cease receipt of wet FGD in Pond 3. MP's evaluation showed dry conversion could be accomplished more quickly than other options, primarily due to steps already taken, shorter construction time frames, and more expedient environmental permitting timelines compared to other alternatives. Once FGD dewatering technology is installed, the dewatered FGD material will be stored in the onsite CCR landfill or beneficially used.

MP also evaluated idling BEC Units 3 and Unit 4 until the selected multi-technology alternatives are in place as a method to cease receipt of CCR and non-CCR wastewaters. However, a temporary idling of these two baseload units between April 2021 and June 2022[1] is expected to cause widespread disruption to the electric grid and have significant negative impacts to public health and safety. Therefore, idling the units is not considered a technically feasible option. Furthermore, due to these disruptions and negative impacts, it is likely BEC would not be allowed by its Regional Transmission Operator (RTO), the Midcontinent Independent System Operation (MISO) to temporarily idle Boswell Unit 3 and/or Unit 4.

In developing these Demonstrations and selecting the fastest technical feasible options for ceasing receipt of CCR and non-CCR wastestreams, MP considered the time needed for environmental permitting, equipment procurement and fabrication, and construction timelines. Therefore, the May 6, 2022 (Pond 3) and June 4, 2022 (BAP) cease receipt timeline extensions are necessary for MP to cease receipt of CCR and non-CCR as soon as technically feasible.

[1] Although Pond 3 is projected to be able to cease receipt of FGD solids by May 6, 2022, the bottom ash conversion project required for BEC Units 3 and 4 to cease receipt of CCR is not projected to be complete until June 4, 2022.

1.0 Introduction

In accordance with the Coal Combustion Residual (CCR) "Part A" rulemaking, Minnesota Power (MP) hereby submits two No Alternative Disposal Capacity Demonstrations under the provisions of §257.103(f)(1): *"Site-specific alternative deadlines to initiate closure of CCR surface impoundments"*. MP is requesting EPA approval to extend the April 11, 2021 cease receipt date under §257.101(a)(1) for two CCR impoundments located at the Boswell Energy Center (BEC) in Cohasset, Minnesota.

MP is requesting to extend the April 11, 2021 deadline to cease receipt of CCR and non-CCR wastestreams for the BEC Bottom Ash Pond to June 4, 2022 and for the BEC Pond 3 to May 6, 2022. The requested dates represent the specific time needed for completion of two distinct dry conversion projects, as well as construction of a new non-CCR wastewater pond. The extension is necessary for engineering, design, permitting, and construction of multiple technologies. As detailed in this demonstration, MP is committed to ceasing receipt of CCR and non-CCR wastestreams in these impoundments as fast as technically feasible, all while upholding our core values of environmental stewardship, safety, reliability, and affordability of electric service for our customers.

1.1 Site-Specific Project Timeline Considerations

Permitting Timelines

MP has assembled the required information showing the sequencing and timing of events needed to cease receipt of CCR and non-CCR wastestreams at these two impoundments as soon as technically feasible. Although not built into any projects timelines, certain factors affecting BEC's extension request are not entirely within MP's control. For example, one of the most time-intensive components for these projects is the associated air and water quality permitting. Under Minnesota state statute, air permits must be received before construction of the project(s) begin.

MP has already taken significant steps in this regard, and has submitted an air permit amendment application and received an anticipated timeline for receipt of final air permits from the MPCA. This proactive approach is anticipated to significantly expedite overall timelines for ceasing receipt of CCR at the BAP and Pond 3. Those applications were submitted on April 15, 2020, and timelines for selected options for ceasing receipt of CCR wastestreams are based off that start date. MP anticipates submittal of NPDES permit modifications for the non-CCR wastewater basin in December of 2020.

However, there is no guarantee the necessary air permits will be issued in the timeframe MP has estimated for this application. Likewise, the installation of a new non-CCR wastewater equalization and settling pond will require modifications to the facility's NPDES permit, which is anticipated to be accomplished through the permit renewal process. Major permit amendments and renewals are subject to public comment and legal challenges, which can cause delays in the permitting and overall project schedule. MP has taken proactive steps to engage both state permitting agencies and tribal entities in advance of these permit actions, and will continue to conduct stakeholder outreach to help ensure timely permit issuance. Title V and NPDES Permit modification steps are detailed below. MP has obtained concurrence with MPCA regarding the required steps and associated timelines for use in evaluating alternative disposal options.

1.1.2 Air Permitting Steps

Air Dispersion Modeling
Based on the preliminary project design, detailed air dispersion modeling must be performed to quantify any increases in air emissions and determine if those increases trigger additional regulatory requirements. Air dispersion modeling is typically performed by a consultant or other person knowledgeable in running modeling software. This step requires approximately two weeks to obtain proposals, select a consultant, and award a contract. The draft modeling protocol prepared by the consultant is reviewed internally. Once the modeling is complete (6-8 weeks) it is submitted to the state agency for review and approval.

Modeling Protocol Review & Approval
The MPCA has a modeling protocol queue that typically ranges from 0-3 months. Once a regulatory agency modeler is assigned by MPCA, the review and approval process ranges from 1-3 months, but can take longer for more complex projects. Additional modeling may be required if the agency requests revisions, which can cause delays in the process. When the MPCA has accepted and approved the modeling protocol, a final modeling report must be included with the permit application for the MPCA to deem the application complete.

Air Permit Major Modification Application
A major permit amendment application can begin to be developed once a project's air dispersion modeling is near completion. Permit applications require a thorough review of all applicable state and federal regulations to determine the appropriate application materials and forms. In many cases, it is beneficial to hire a knowledgeable consultant for this task, since incomplete applications can delay overall permitting. The same consultant utilized to develop the modeling protocol is typically used by MP for the permit application, therefore the need to obtain proposals is not necessary for this step and is not included in our timeline. A draft application prepared by the consultant goes through an internal review process. Once the application is finalized, it is submitted to the state agency.

Permitting Queue
An air permit application will be placed in the state queue, which typically ranges from 0-6 months. It is important to note an application will not be considered complete, and a permit writer cannot be assigned, until the modeling protocol is approved. An application may remain in the modeling queue until modeling is approved if the applicant waives the 30-day completeness determination. When the application is complete and reaches the top of the queue, a permit engineer is assigned. A permittee may opt to pay additional permitting fees associated with a permit writers voluntary overtime to expedite the

permitting process; however, because agency staff are working on their own time, this does not guarantee or result in a more expedient permitting process. Therefore, MP did not pursue an expedited permitting process.

Permitting

The timeline for drafting a permit can vary based on project complexity, but is generally anticipated to take 2-3 months. During this time the permit writer is reviewing the application, obtaining any additional information necessary, and developing draft permit language. Once the draft permit has been prepared, it will go through approximately 2 weeks of internal agency review and a 7-day pre-public notice review by the permittee. The agency will address comments received from the permittee and make any necessary revisions to the draft permit. This step can take a few days to a couple of weeks. Once the draft permit is prepared the agency or permittee is responsible for outreach to public stakeholders.

Public Comment & EPA Review

The draft permit must go through a 30-day public comment period and a 45-day EPA review. The agency must address public comments. The time necessary for this is determined by the number and type of comments received, but typically takes 0-3 weeks. Once comments are addressed the state will issue a final permit.

	MPCA Title V Air Permit Amendment Process	Length of Time	Justification/Comments
1	Submit Modeling Protocol	-	
2	Modeling Queue	0-3 months	Queue can vary based on the number of projects in need of review
3	Modeling Process and Modeling Report Approval	1-3 months	Detailed review of modeling assumptions
4	Submit Permit Amendment Application	-	Modeling Approval required for a complete application
5	Permit Application Completeness Review	*30 days	Time allotted to the agency to determine if an application is complete
6	Permitting Queue	**6 months	Queue can vary based on the number of applications
7	Permitting Process	2-3 months	Process timeline can vary based on extent of permit changes
8	Draft Permit – Agency Internal Review	2 weeks	
9	Draft Permit – Permittee Review	7 days	Review time is limited to 7 days for permittee
10	Draft Permit Revisions	0-2 weeks	Time needed can vary based on the extent of revisions needed
11	Stake Holder/Public Review	2 weeks	Tribal consultation, etc.
12	Public Notice	30 days	Mandatory public comment period
13	EPA Review	45 days	Mandatory EPA review period – MPCA can request a shorter 15 day review if no public comments were received
14	Address Public Comments	0-3 weeks	Time needed can vary based on extent of public comments received
15	Finalize Permit	1 week	

*Permittee may submit the modeling protocol and a permit application at the same time but must opt to waive the 30 day completeness review to keep the application in the queue while modeling protocol is reviewed

**Permittee may apply for expedited permitting to skip the queue, these permits are voluntary processed by MPCA staff on overtime paid for by the permittee

Table 1. *A timeline showing the specific steps and anticipated timeframes associated with obtaining a major permit amendment through the Minnesota Pollution Control Agency. It is important to note that expedited permitting does not guarantee faster issuance of the final permit, especially for complicated permit amendments.*

1.1.3 NPDES Permitting Steps

Typically, major facility modifications such as changes to water quality at designated outfalls or addition of new outfalls cannot be made without a full permit reissuance by the MPCA. MP submitted a timely application for BEC's permit reissuance on August 30, 2011; however, the permit has not been reissued and is administratively extended. The MPCA generally considers permit reissuances to be "non-priority" permit actions because they do not typically authorize construction or modification. The MPCA will assign these permits to permit writers as they are available. Because of this and other factors, including permit application backlogs, complexity and evolving regulatory issues, and public interest, the MPCA has not yet reissued BEC's NPDES permit.

Based on this information, MP believes the appropriate permitting timeline for the non-CCR pond is a major NPDES permit renewal. NPDES major permit reissuance timelines are largely based on the complexity of the permit, associated applicable regulations, and the need for the MPCA to address public comment and interest. The NPDES permit reissuance process requires the same internal and external review as air permits described above. Table 2 below provides an outline of the water permitting steps and time needed to execute each step; this information was received from the MPCA on November 5, 2020. Any alternative option that involves continued storage, handling, and discharge of CCR wastewater is assumed to take longer to permit, based on project and permit complexity and the likelihood of increased public comment. Estimated timelines for NDPES permitting were included where applicable in the alternatives analysis. Three important steps in the NPDES permitting process are described in more detail below.

<u>Permitting</u>
The water permitting process varies based on permit complexity, but generally takes four months. As part of the permit drafting process MPCA conducts a completeness review, technical review, impaired waters/total maximum daily load review, and an effluent limits review. Water permit writers prepare an effluent limit sheet with the necessary information for review by MPCA's Effluent Limits team. This team reviews the information and sets the effluent limits. The MPCA permit writer then develops the permit and supporting documents including statement of basis.

<u>Review Period</u>
The draft permit then undergoes a permit review process, which typically takes 1.5 months. This includes a mandatory EPA review period focused on 316(b) and Steam Electric Effluent Limitations Guidelines (ELG) regulations.

<u>Public Notice</u>
The mandatory public notice period for the NPDES permit is 30 days. The MPCA has a strong commitment to public engagement and tribal government consultation. The agency must address all public comments. The time necessary for this is determined by the number and type of comments received, but typically takes 0-3 weeks. MP's past permit actions have received comments. MP continues to engage stakeholders, including

tribal government representatives prior to and during its permitting actions to keep them updated and address their concerns where possible to minimize delays to the permitting timeline. Once comments are addressed the state will issue a final permit.

MPCA NPDES/SDS Permit Renewal Process	Length of Time	Justification/Comments[2]
Submit Revised Permit Application		Facility submits updated permit application
Application Completeness Review	30 days	Time allotted to the agency to determine if an application is complete
Effluent Limit Review	1-3 months*	Discharge is changing based on coal combustion residual (CCR) rule. Facility is converting to dry ash handling and decommissioning the CCR ponds. Permit will need effluent limits and monitoring review for existing and proposed discharges.
Technical Review	0-3 months*	
Permitting Process - Draft Permit	2-3 months*	Process timeline can vary based on extent of permit changes
Draft permit - Agency Internal Review	2 weeks	
Draft Permit - Permittee Review	7 days	
Draft Permit Revisions	0-2 weeks	Time needed can vary based on the extent of revisions needed
Stakeholder Review	2 weeks	
EPA Permit Review	30 days	Mandatory focused EPA review period based on 316(b) and steam electric ELGs. Done prior to public notice.
Public Notice	30 days	Mandatory public comment period
Address Public and EPA Comments	0-3 weeks	Time needed can vary based on the extent of public comments received. EPA is to notify MPCA if they are going to object the permit (ideally within 15 days) of which they then have 90 days to provide written comments to MPCA.
Finalize Permit	1 week	

Table 2. *A timeline showing the specific steps and anticipated timeframes associated with obtaining a NPDES permit through the Minnesota Pollution Control Agency and EPA. Items noted with asterisk (*) represent timelines that will likely be concurrent.*

1.1.4 Weather

Once permits are received, equipment procurement, fabrication, and construction will occur. In order to ensure adequate construction conditions, earthwork construction activities must take place during non-frozen conditions between April and October. Working in frozen conditions can cause structural issues to develop during construction or operation, and potentially delay cease receipt of CCR and non-CCR waste streams in the BAP and Pond 3. BEC is located in a cold, wet environment of northern Minnesota, and climate conditions play a significant role in project schedules. One example of the challenges associated with construction in northern Minnesota are road restrictions issued by the Minnesota Department of Transportation (MnDOT). In late winter and early spring, road restrictions for middle- to full-overweight highway permits (often needed to mobilize heavy equipment for major construction activities)

[2] Justification comments are from MPCA NPDES permitting staff.

typically persist until late May to early June[3]. While road restrictions may not be a limiting factors for ceasing receipt of waste streams at BEC's clay-lined impoundments, the road restriction data compiled by the MnDOT clearly show the lengthy timeframes and associated schedule impacts of cold, wet weather on construction activities. Protecting concrete from freezing is another significant challenge when working in cold weather. The Portland Cement Association (PCA) states that concrete which freezes prior to obtaining design strength results in disruption of the cement paste matrix, which can cause an irreparable loss in strength, and a reduction of up to 50 percent in ultimate strength. Technical specifications for concrete construction typically reference American Concrete Institute (ACI) standards, which prohibits placing concrete on frozen subgrade material. The frost depth in northern Minnesota ranges from 48 inches to greater than 60 inches based on the US Department of Commerce, showing proper ground conditions for excavation and concrete construction are highly dependent on time of year.

MP intends to begin construction activities as soon as technically feasible after the required permits are secured. Based on estimated permitting timeframes, MP anticipates issuance of permits in the spring of 2021, allowing for procurement and construction activities to begin after receipt. However, if permits are significantly delayed, there are significant technical and logistical challenges associated with beginning earthwork activities in frozen conditions.

Regardless of permitting and weather uncertainty, MP is committed to ceasing receipt of CCR and non-CCR in these impoundments as soon as technically feasible. MP's dry conversion and non-CCR wastewater pond plans accomplish that goal while improving BEC's overall environmental performance.

[3] http://www.dot.state.mn.us/materials/pvmtdesign/sll/index.html

2.0 Facility Description & Impoundment Descriptions

Minnesota Power (MP) owns and operates Boswell Energy Center (BEC) in Cohasset, Minnesota. BEC generates 940 megawatts (MW) from two coal-fired units, Unit 3 (355 MW) and Unit 4 (585 MW), and is the largest thermal generating facility in Minnesota Power's fleet. Two smaller generating units, Units 1 and 2, were retired at the end of 2018. CCR and non-CCR wastestreams at BEC are managed on-site in a clay-lined, approximately 600-acre CCR management system that was constructed in 1980. The CCR management system consists of three-surface impoundments referred to as Pond 3, Pond 4, and the Bottom Ash Pond (BAP), as well as a Dry Ash Landfill. The CCR management facilities are shown in Figure 1.

Pond 3

BEC Unit 3 is equipped with a selective catalytic reduction unit (SCR) and baghouse followed by a wet flue gas desulfurization scrubber (FGD) as part of the air quality control system (AQCS). Dry fly ash is captured in the Unit 3 baghouse and is pneumatically conveyed to an onsite silo then transported offsite for beneficial use as a cement replacement in concrete. Ash that does not meet specifications for cement replacement is disposed of in the on-site Dry Ash Landfill. The wet FGD material is sluiced to Pond 3.

BEC Pond 3 is a clay-lined 142-acre surface impoundment that is part of a closed-loop system designed to capture and store FGD scrubber solids while returning decanted water to the plant for re-use in system operations. The pond receives 150-200 gallons per minute of FGD sluice from Unit 3, with a solids accumulation rate of approximately 30,000 cubic yards per year depending on electrical generation rates. In Pond 3, the residence time for the incoming slurry allows the solids to settle out and remain in the pond, while the clarified water is decanted from the pond and pumped back to the plant for reuse in the Unit 3 AQCS and Unit 4 AQCS systems. Pond 3 is not used for storage of any non-CCR wastewater streams. This pond is subject to the 2018 USWAG Decision and subsequent EPA rulemaking revisions and closure under the five-foot aquifer separation location restriction requirement. Options evaluated by MP to cease receipt of CCR in Pond 3 as soon as technically feasible are described in Section 4.

Bottom Ash Pond (BAP)

BEC Unit 4 is equipped with Selective Non-Catalytic Reduction and low NOx (nitrogen oxides) burners, followed by a circulating semi-dry scrubber/fabric filter. The Unit 4 fabric filter was installed in 2015 as an air quality control system upgrade. Dry ash that is captured by the fabric filter is conveyed to an on-site silo before being transferred to the facility Dry Ash Landfill. Pond 4 is no longer used for disposal of CCR and is not included in this demonstration.

The Boswell BAP is a 62-acre surface impoundment and receives sluiced bottom ash from Units 3 and 4. Bottom ash settles out and accumulates in the BAP, while the clarified water is decanted from the pond and pumped back to the plant for reuse or treatment and discharge. Bottom ash accumulates in the pond at a rate of approximately 50,000 to 60,000 cubic yards per year, depending on electrical generation rates.

A secondary but critical function of the BAP is to provide settling and equalization for stormwater and non-CCR process waters from plant operations, including cooling tower blowdown, cooling tower drainage, boiler drainage, coal pile basin, wastewater treatment pond dredging effluent, floor drains, and plant sumps. Once settled and equalized, wastewater streams not reused in plant processes are further treated through BEC's on-site wastewater treatment plant and discharged to surface water in accordance with the facility NPDES Industrial Wastewater Discharge Permit (MN0001007). Because settling and equalization of wastewater must continue to occur to meet NPDES permit limits, ceasing receipt of these non-CCR wastestreams in the BAP required the development of storage alternatives. Options that were evaluated to cease receipt of CCR and non-CCR wastewater in the BAP as soon as technically feasible are described in Section 4.

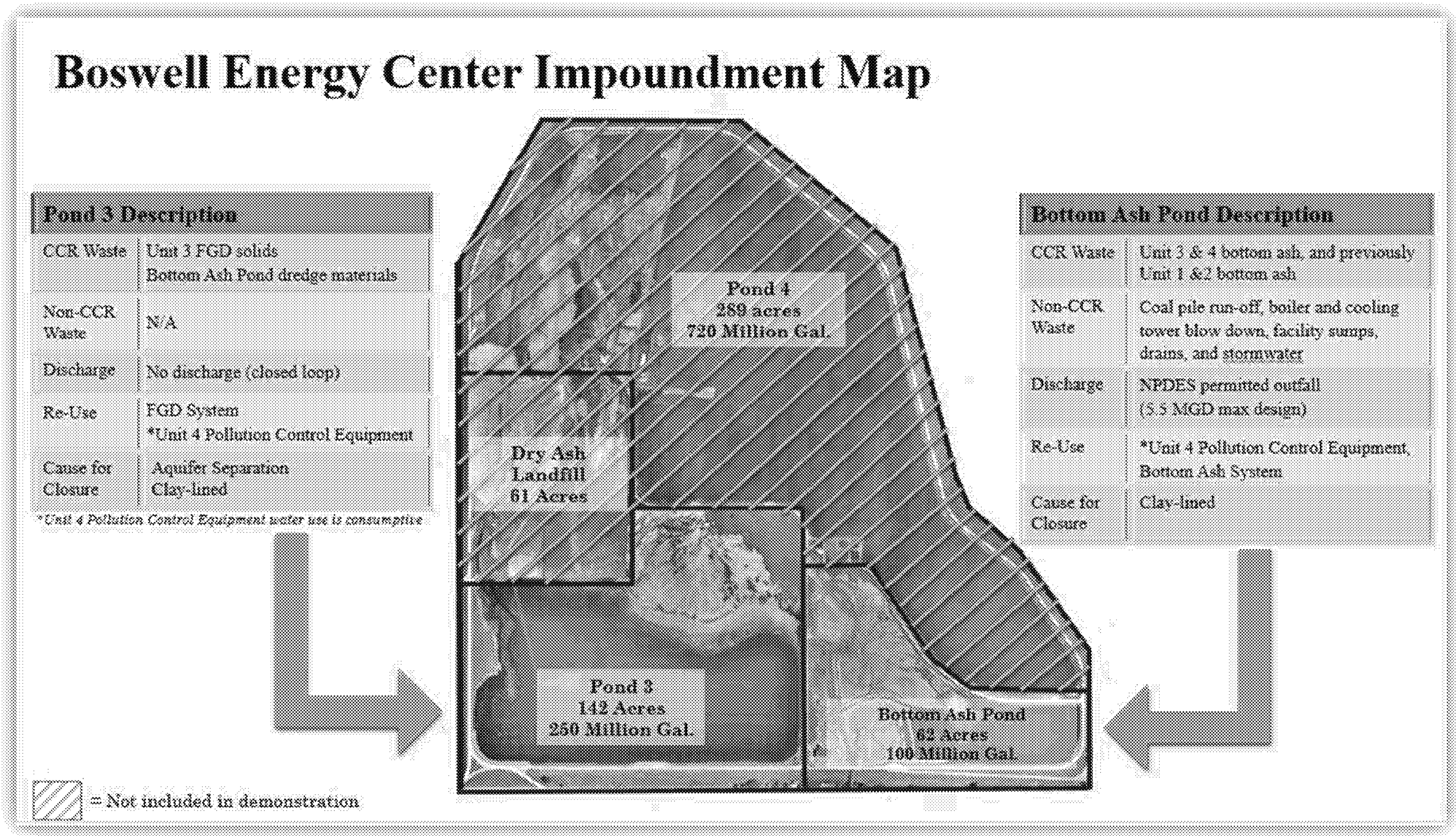

Figure 1. *Boswell Energy Center Impoundment Map*

3.0 Multiple Technology System Implementation Overview

MP has determined a multi-technology system is the fastest technically feasible option for ceasing receipt of CCR and non-CCR wastestreams at BEC's clay-lined impoundments. MP plans to transform the existing wet CCR system in a way that minimizes or eliminates new wastewater discharges to surface waters, reduces the generation of additional waste material or sludge from wastewater treatment, and complies fully with all local, state, and federal regulations. In doing so, MP will have selected a comprehensive option that reduces risks of extended permitting and construction timelines in comparison to other options, such as permitting and building a new CCR impoundment.

The multi-technology option will be accomplished by simultaneously undertaking multiple large-scale projects to convert Unit 3 and Unit 4 to dry bottom ash handling, install an FGD gypsum dewatering system on Unit 3, and develop new settling and equalization capacity for non-CCR wastewaters currently going to the BAP. The multiple technologies selected are the fastest technically feasible alternatives and meet the requirements necessary for an extension as demonstrated in the workplan presented in Sections 5 and 6. A summary of each of these projects is provided below. A timeline summarizing the schedule for implementation of all three projects simultaneously is provided in Figure 2.

A. Pond 3 FGD Gypsum Dewatering System

Disposal of sluiced CCR in Pond 3 will be eliminated through the installation of a gypsum dewatering system. This will separate gypsum solids from the waste stream as a dry product and leave a small filtrate waste stream that will be reused in plant processes. The dry product will be disposed of in the onsite CCR landfill or beneficially used.

B. BAP Dry Bottom Ash Conversion

Disposal of sluiced CCR in the Bottom Ash Pond will be eliminated through conversion of both Units 3 & 4 to dry bottom ash handling systems. The dry bottom ash will be stored in the onsite CCR landfill or beneficially used.

C. BAP Alternative Storage for Non-CCR Wastestreams

Disposal of non-CCR wastewater in the BAP will be eliminated by construction of a new basin for wastewater settling and equalization purposes. The non-CCR wastewater streams will continue to be treated and discharged under BEC's NPDES permitted outfall.

General Multi-System Project Timeline

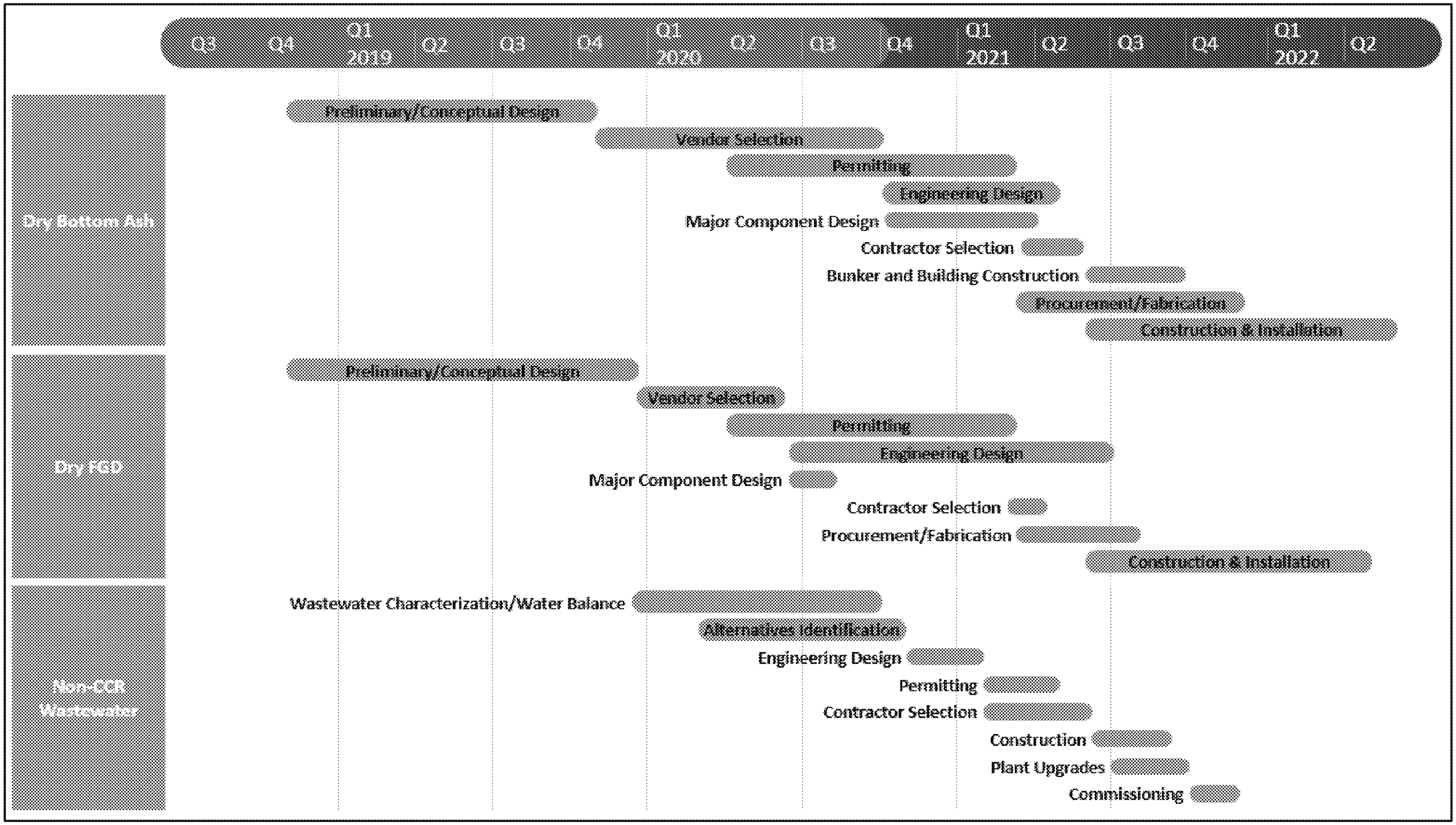

Figure 2. *Overview of actions and time required for BEC's multiple CCR Projects. More detailed timelines are included below.*

4.0 Alternative Capacity Analysis & Selection – §*257.103(f)(1)(ii)(A)(1)*

For Pond 3 and the Bottom Ash Pond an alternative capacity evaluation per §257.103(f)(1)(ii)(A)(1) requires:

(1) A written narrative discussing the options considered both on and off-site to obtain alternative capacity for each CCR and/or non-CCR wastestreams, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option selected and justification for the alternative capacity selected. The narrative must also include all of the following:

(i) An in-depth analysis of the site and any site-specific conditions that led to the decision to select the alternative capacity being developed;

(ii) An analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use; and

(iii) A detailed explanation and justification for the amount of time being requested and how it is the fastest technically feasible time to complete the development of the alternative capacity;

At BEC there is currently no alternative CCR or non-CCR wastestream capacity available on or off-site, and no way to transport current wet CCR wastestreams off-site. MP conducted alternative capacity evaluations for CCR and non-CCR wastestreams based on three major criteria: technical feasibility of implementation, time necessary for environmental review and permitting (including steps already taken), and time necessary for equipment procurement and construction. Combined, these factors contributed to determining which options are the fastest technically feasible cease receipt date for CCR and non-CCR waste streams. A description of each of these factors is provided below.

1. Technical Feasibility

In the Part A Rule, EPA defines *technically feasible* as "possible to do in a way that would likely be successful". Permitting complexity, construction time, operational compatibility, and environmental/regulatory restrictions were all taken into consideration in this step.

2. Permitting Timeframes

Alternative options evaluated by MP require modifications to the facility Title V Air Permit and NPDES permit, as well as potential environmental review prior to permitting. A detailed discussion of the permitting requirements and necessary steps and time needed to execute each is included in Section 1.1. This overall review and permitting timeline, including steps already taken, was taken into consideration during the alternative analysis.

3. Procurement and Construction Timelines

The length of time needed to procure equipment and construct each alternative is a key consideration for determining the fastest technically feasible solution. Projects that require extensive construction inherently take more time to complete, and projects that require outdoor activities such as excavation, grading, vegetative growth or concrete installation are subject to weather conditions. For example, excavation work requires frost to be out of the ground before work can begin and concrete work requires soil conditions and air temperatures warm enough to prevent freezing of poured concrete. As noted previously, in northern Minnesota adequate earthwork conditions reliably exist only during the timeframe of April-October.

4.1 Alternative Selection – *§257.103(f)(iv)(A)(i)*

Pond 3

MP selected FGD gypsum dewatering as the fastest technically feasible approach to cease disposal of CCR in Pond 3. The selected option is expected to be complete May 6, 2022, or 25 months after the permit application submittal date of April 15, 2020. The earliest dates the other technically feasible options would be expected to be complete is between Novermber 2022 (New Tanks) to December 2024 (Impoundment Retrofit).

MP's determination takes into consideration the time necessary for permitting and construction. Installation of the gypsum dewatering system requires a major modification of the facility Title V Air Permit. The time necessary to obtain a modified air permit was determined based on the steps and timelines described above in Section 1.1. Per conversations with MPCA as late as November 5, 2020, air permitting is currently estimated to take 11 months from submittal of the air permit application, which again was submitted in April 15, 2020. No other permits or approvals are required for this project. Once permitting is complete, the gypsum dewatering system equipment procurement (5 months) and construction (11 months) can proceed. Some procurement and construction can occur concurrently, for a total procurement and construction timeline of 14 months. Procurement, construction, and installation timelines are further detailed in Section 5.3. The time needed to permit and install a FGD gypsum dewatering system is shorter than other alternatives as described in Section 4 below, and is therefore the fastest technically feasible option for this facility.

Pond 3 - FGD Gypsum Dewatering Technology Overview

Disposal of FGD CCR material from the AQCS currently occurs through a sluice line, which combines gypsum solids from hydro cyclones with additional water to sluice scrubber solids to Pond 3. Installation of a FGD gypsum dewatering system on Unit 3 will be used to separate gypsum solids from the wastewater stream to create a dry product. The dewatered product will be conveyed to a material load out building, then hauled to the on-site Dry Ash Landfill for disposal or be beneficially used following all local, state, and federal requirements. Contract specifications for the gypsum dewatering equipment requires that the dewatered FGD material meet EPA's Paint Filter Liquid Test for landfill disposal. A small filtrate wastewater stream will be generated from this process, but can be reused in existing plant processes, eliminating the need for an impoundment or a surface water discharge.

Bottom Ash Pond (BAP)

The selected alternative to cease disposal of CCR in the BAP is conversion to dry bottom ash handling on both Units 3 and 4, as well as construction of a new wastewater settling and equalization basin for non-CCR wastewaters.

Bottom Ash Dry Handling

MP determined dry bottom ash conversion is fastest technically feasible option given the length of time necessary for permitting and construction. The selected option is expected to be complete June 4, 2022, or ~26 months after the permit submittal date of April 15, 2020. The earliest dates the other technically feasible options would be expected to be complete is between December 2022 (New Concrete Basin) to December 2024 (Impoundment Retrofit).

This bottom ash conversion project requires a major modification of BEC's Title V air permit. Per conversations with MPCA as late as November 5, 2020, air permitting is currently estimated to take 11 months from submittal of the air permit application, which was submitted on April 15, 2020. Once permitting is complete, the bottom ash equipment procurement and construction (15 months) can proceed, some of which can occur concurrently. Procurement, construction, and installation timelines are further detailed in Section 6.3.

MP also believes that the selection of dry bottom ash conversion rather than a new impoundment and discharge of bottom ash transport water reduces the risk of having permit delays or denials, either of which could significantly delay the cease receipt of CCR and non-CCR in the BAP. The potential for permit delays is represented in the range of implementation timelines in Table 2 (e.g. 30 to 96 month timeframes, with the longer timeframes (96 months) representing lengthier permitting and review processes).

Bottom Ash Pond – Dry Conversion Technology Overview

Bottom ash material removal from the boilers currently occurs through a sluice line, which combines bottom ash solids from the hoppers with additional water to sluice to the bottom ash pond. This occurs for both Unit 3 and 4.

Dry bottom ash conversion involves installation of a submerged grind conveyor on each unit. The dewatered product is then conveyed from each unit to a common material load out building and beneficially reused or hauled to the on-site Dry Ash Landfill for disposal. Contract specifications for the submerged grind conveyor require that the dewatered bottom ash material meet EPA's Paint Filter Liquid Test for landfill disposal.

BAP Non-CCR Wastewaters

MP determined a new equalization and settling basin is the fastest technically feasible option for ceasing receipt of non-CCR wastewaters in the BAP. The selected option is expected to be complete November 30, 2021, or ~12 months after the planned NPDES permit submittal in

December 2020[4]. The earliest dates the other technically feasible options would be expected to be complete is between October 2022 (Existing or New Tanks) to February 2023 (Municipal Wastewater Treatment). These timelines are further detailed in the project narrative in Section 6.3.

4.2 Off-Site Alternatives Analysis (CCR)[5]

Option 1: Off-Site Wet Hauling/Landfilling (Pond 3 & BAP)
This option is not technically feasible for the reasons described below.

The FGD Air Quality Control System (AQCS) scrubber produces a wet slurry of gypsum solids and water that is pumped to Pond 3 utilizing centrifugal slurry pumps and pressure-main pipeline. Since the waste stream from the scrubber contains significant water, landfilling off-site is not feasible without first dewatering the CCR materials. The Resource Conservation and Recovery Act (RCRA) mandates that saturated wastes cannot be placed in landfills. There are no other active CCR-compliant surface impoundments within MP's fleet (on-site or off-site) to receive wetted wastes. Likewise, there are no independently or utility-owned CCR-compliant surface impoundments within MP's service territory, or in northern Minnesota within a 50-mile radius of BEC, to receive wetted wastes. The closest landfill is located 31 miles from the facility; however, dry conversion still needs to occur to separate the solids from the water prior to transport to the off-site landfill.

Similar to the operation of Pond 3, the BAP receives slurry from plant operations via centrifugal slurry pumps and pressure-main pipelines at a rate of 1500 - 2500 gallons per minute from each Unit. Both Unit 3 and Unit 4 have bottom ash sluicing systems that can be operated independently of each other. The bottom ash sluice streams contain a significant amount of water (only approximately 1-2% solids in sluice streams). Therefore, similar to Pond 3, hauling and landfilling wet CCR materials off-site is not feasible for the BAP.

Option 2: Municipal Wastewater Treatment (Pond 3 & BAP)
This option is not technically feasible for the reasons described below.

Based on discussions with local Publicly Owned Treatment Works (POTW) representatives in Cohasset and Grand Rapids, Minnesota, the municipal facility does not have the infrastructure available to handle the CCR solids currently in the wastewater. Therefore, MP would still be required to separate solids from the wastewater slurry due to provisions in 40 CFR 403, as well as conduct pre-treatment of the remaining waste stream. Absent such infrastructure, this is not a viable option to cease receipt in either Pond 3 or the BAP.

[4] The June 4, 2022 cease receipt date for the BAP accounts for the additional time needed to complete the dry ash conversion projects described above to cease receipt of CCR wastes.

[5] All on-site and off-site options are included in Table 3, and are numbered sequentially for clarity.

4.3 On-Site Alternatives Analysis (CCR)

Option 3. Existing Surface Impoundments (Pond 3 & BAP)
This option is not technically feasible for the reasons described below.

All of the existing surface impoundments at BEC are clay-lined and therefore required to cease receipt of CCR as soon as technically feasible under EPA's Part A Rule.

Option 4. On-Site Landfilling (Pond 3 & BAP)
This option is not technically feasible for the reasons described below.

Boswell does not currently have equipment to dewater the FGD or bottom ash sluice streams prior to placement of wastestreams in the on-site Dry Ash Landfill. The existing Dry Ash Landfill cannot be used to manage the sluiced FGD or bottom ash waste streams in the current state.

Option 5: Existing Tank Use
This option is not technically feasible for BAP or Pond 3 for the reasons listed below.

The BAP receives flows of 1.5-2.0 million gallons per day (MGD), and has a total estimated capacity of 100 million gallons. This results in a residence time of approximately 50-67 days. There are no existing tanks or infrastructure available at BEC to provide this kind of capacity.

For the Pond 3 FGD slurry, which has lower flow rates, MP evaluated use of existing tanks at BEC, some of which have been out of service for many years, to create storage capacity and provide necessary settling time for clarification. Based on MP's evaluation of the flow and volume of the FGD system, no individual tank is large enough to provide the necessary capacity or the necessary residence time to settle out the solids prior to sending clarified water back to the FGD system. Without a single tank that can handle the FGD flows, a series of tanks would be necessary. Available tanks at BEC are spread out across the site and would need to be plumbed and connected to the plant sump system, and the integrity of all tanks would need to be assessed. The existing tanks do not have the systems necessary for sludge management, which also adds time and challenges to existing tank retrofit option. The existing tanks that would be suitable for retrofit do not have the volume or equipment necessary to effectively clarify the FGD wastestream, therefore, repurposing of existing infrastructure and tanks is infeasible for handling of FGD wastestreams.

Option 6. Impoundment Retrofit (Pond 3 & BAP)

The retrofit of existing impoundments is a technically feasible option; however, this option is expected to take up to December 2024 or longer to implement, significantly longer than the selected options (May 6, 2022 for Pond 3 and June 4, 2022 for BAP).

Pond 3

Pond 3 is clay-lined and would need to be retrofitted with a CCR-compliant composite liner system in order to continue operation. However, Pond 3 does not meet the five-foot groundwater separation location requirement. To comply with the CCR rule, Pond 3 would first need to be fully dewatered. Dewatering the approximately 200 million gallons in Pond 3 on an expedited timeline would require installation of a water treatment system to meet current NPDES permit requirements for surface water discharge. Dewatering 200 million gallons of Pond 3 water, plus the associated precipitation that falls within the pond footprint and any water entrained within FGD solids, would take at least 12 months to accomplish.

After dewatering, retrofit would require the CCR be removed and fill placed at the base of the impoundment to create the required aquifer separation distance before installing a composite liner system. Construction time, fill, and installation of a composite liner, based on engineering estimates, is expected to take 36–48 months. Based on anticipated project timelines, retrofit of Pond 3 is not the fastest technically feasible alternative for ceasing receipt of CCR in Pond 3

BAP

The BAP is also clay-lined and actively receiving bottom ash from Units 3 and 4. The BAP is the only surface impoundment at BEC that can receive sluiced bottom ash while maintaining compliance with existing regulatory permits. The BAP cannot be taken out of service to dewater and retrofit the pond with a composite liner system. The BAP would have to be segmented and dewatered in sections to isolate portion(s) of the pond to allow clean closure and installation of a composite liner system, all while maintaining active sluicing operations in other portions of the pond. There is approximately ten to twenty feet of bottom ash in the bottom of the pond that would need to be removed to connect to the existing clay liner. Once the clay liner was reached, an impermeable barrier would need to be constructed to hydraulically isolate a portion of the pond. Based on engineering estimates the time necessary to complete this work would range from 36–48 months. Based on anticipated project timelines, retrofit of the BAP is not the fastest technically feasible alternative for ceasing receipt of CCR in the BAP.

Option 7. New Surface Impoundment (Pond 3 & BAP)

Construction of a new on-site surface impoundment for Pond 3 and the BAP is a technically feasible option; however, this option is expected to take up to June 2023 or longer to implement, significantly longer than the selected options (May 6, 2022 for Pond 3 and June 4, 2022 for BAP).

A new surface impoundment would need to be designed and constructed to meet all state and federal requirements. A significant potential timeline issue associated with this approach is the potential for an Environmental Assessment Worksheet (EAW) and Environmental Impact Statement (EIS), followed by extensive permitting required by the MPCA and Minnesota Department of Natural Resources (MDNR).

While the creation of a new CCR impoundment may not trigger a mandatory EAW, discretionary EAWs are sometimes required for projects considered to have environmental impacts similar to mandatory EAW thresholds. This can be requested by citizens to Minnesota's Environmental Quality Board (EQB), and the Responsible Governmental Unit (RGU) then decides whether the project has the potential for significant environmental effects, or "the perception of such"[6]. For example, MN Rule 4410, Subpart 24(B), requires a mandatory EAW "for a new permanent impoundment of water creating additional water surface of 160 or more acres or for an additional permanent impoundment of water creating additional water surface of 160 or more acres…"

Again, while a new impoundment at BEC may not meet the mandatory criteria of 160 acres, there is certainly a possibility that a discretionary EAW could be requested and granted for a new CCR impoundment in Minnesota. One of MP's professional engineering and environmental consultants, Barr Engineering, indicated it would be likely that a discretionary EAW would be sought for a new CCR impoundment at Boswell. Based off consultant experiences and conversations with MPCA staff, completion of an EAW has the potential to further extend the timeline by months or years. More detail is provided below.

If an EAW were required, the MPCA would likely be the RGU. Barr Engineering estimates that completion of the EAW prior to submittal to the RGU can be accomplished in three months under certain circumstances; however, wetland delineations, threatened and endangered species studies, or air or water modeling can extend that EAW preparation time to 6-12 months. MPCA's website and staff[7] state that environmental review alone can take 4-6 months after receipt of the EAW, however complex projects may take longer. Barr Engineering indicates that 6-12 months is a more typical processing time for EAW, with a total environmental review period of 9-24 months. MPCA does not review permit applications until the environmental review is complete, so these tasks could not occur concurrently. If an EIS is required after the EAW, the timeline could be extended at least a year and possibly longer. Additionally, a MDNR Dam Safety Permit reissuance for an impoundment would also be required.

Based on engineering estimates, design and construction of a new CCR impoundment could take up to June 2023 to complete at earliest. However, due to the likelihood of extensive environmental review and permitting timelines described above that would precede construction,

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[6] https://www.eqb.state.mn.us/sites/default/files/documents/Quick%20Reference%20-%20EAW.pdf

[7] Phone message exchanges between Dan Card (MPCA) and Kurt Anderson (MP) on October 29, 2020.

and the uncertainty of MP's ultimate ability to receive necessary approvals, this project could take up to 96 months to complete, or up to December of 2028. Under either scenario, this option would take significantly longer to complete than alternatives selected by MP.

Option 8(a): New Tank(s) for FGD

A new tank is technically feasible for Unit 3 Pond; however, this option is expected to take up to November 2022 to complete, longer than the May 6, 2022 timeframe for the selected option. This option would entail installation of a series of new tanks at BEC to handle storage and clarification of the FGD wastewater flows. The new tanks would need to be designed to have sufficient storage capacity to handle the flows, provide settling time for solids and sludge/solids handling capabilities. In addition to the installation of storage tanks, major upgrades would be required to plumb and route the streams to the new tanks. Importantly, this option would also require installation of a dewatering technology to prepare the clarified solids for disposal in the onsite landfill, similar to the selected option for Pond 3.

The time necessary to complete the construction of the tank project, based on Barr Engineering estimates, is 12-18 months. For the purposes of this analysis, construction of the tank system and the required FGD system occurs concurrently. The tank construction timeframe includes: Evaluation of the best location for the tanks; evaluation of the underground utilities in the location; relocation of the utilities; excavation and site preparation; installation of foundations for tanks; procurement and delivery of tank material; procurement and delivery of dewatering equipment; rerouting and retrofitting of existing infrastructure; and startup and commissioning of system.

As stated earlier, dewatering of the FGD slurry material and associated trucking requires a major modification of the Facility Title V air permit, which is currently underway for the selected option. Altering the current permit application to include a tank option upstream of the FGD dewatering process would require modifications to the permit application. MP would need to incorporate tank infrastructure information into the existing permit application, which can also cause MP to lose our current place in the permitting queue. This could effectively restart the permit application process, which for purposes of this analysis is then calculated to begin anew in December of 2020. Installation of tanks is also anticipated to require at least an NPDES permit engineering approval, which is estimated to take at least 60 days. For this analysis, MP determines this could be conducted concurrently with Title V permit issuance. In total this project is expected to take 23-30 months.

Option 8(b): New Tank(s) for BAP

This option is not technically feasible for the BAP, for the same high flow volumes outlined in Option 5.

Option 9: Construction of a New Concrete Sedimentation Basin (BAP only)

Construction of a new on-site concrete sedimentation basin to replace the BAP is a technically feasible option; however, this option is expected to take up to December 2022 or longer to implement, significantly longer than the selected option (June 4, 2022). A similar option was considered for Pond 3, but due to the characteristics of the FGD slurry, and the settling time required, Pond 3 alternatives are discussed under Option 7 and Option 8(a).

A new concrete sedimentation basin to replace the BAP would allow separation and subsequent landfilling of the solids. However, this approach faces the same NPDES and dam safety permitting hurdles, as well as risks of delay, to that of a new impoundment. Based on engineering estimates provided by Barr Engineering, the construction time for a concrete basin is estimated to take 12-18 months. Construction could only occur when soil and air temperatures are warm enough to prevent freezing of poured concrete, and therefore all work must be completed during the April-October construction season in Minnesota, as previously described in Section 1.1. Similar to construction of a new impoundment, this project would take longer to complete than the alternative selected by MP.

4.4 Non-CCR Wastewater Alternatives Analysis

MP evaluated the options described below specifically for alternative non-CCR wastewater storage capacity. Importantly, although the Part A Rule is clear that non-CCR wastewater streams should be addressed individually and cease receipt achieved as soon as technically feasible for each stream, separation of individual non-CCR wastewater streams at this facility on a stream-by-stream basis is not the fastest approach to eliminating disposal of non-CCR wastewaters in the BAP.

Non-CCR wastestreams are currently managed within the existing plant sump system where the BAP serves a critical surge capacity role during upsets or times of high stormwater flow (i.e. large rain events, spring snowmelt, etc.). The BAP also provides settling time and ensures that mixed wastewater streams are of consistent water quality before discharge through the facility Central Wastewater Treatment Facility (CWWTF) which is regulated under Boswell's NPDES Industrial Wastewater Permit MN0001007.

Separation of the wastewater streams would require the facility to reintegrate separated wastewater streams for treatment and discharge via the currently permitted NPDES outfall. The wastewater system at BEC is highly integrated and complex, as depicted visually in Figure 3, below. Isolating and redirecting wastewater streams requires an evaluation of flow rates, volumes, and water quality to determine impacts on resulting wastewater quality. Furthermore, subsequent to each individual wastewater stream being directed away from the BAP, a new analysis must be performed for the altered wastewater composition.

Based on internal engineering estimates, this complex and iterative process is expected to take a minimum of 30 months, much longer than construction of a new non-CCR basin. Additionally, facility pumps and pipes are difficult to access and re-route due to being located underground and beneath concrete floors, therefore lengthy construction efforts would be anticipated in addition to the extensive evaluation.

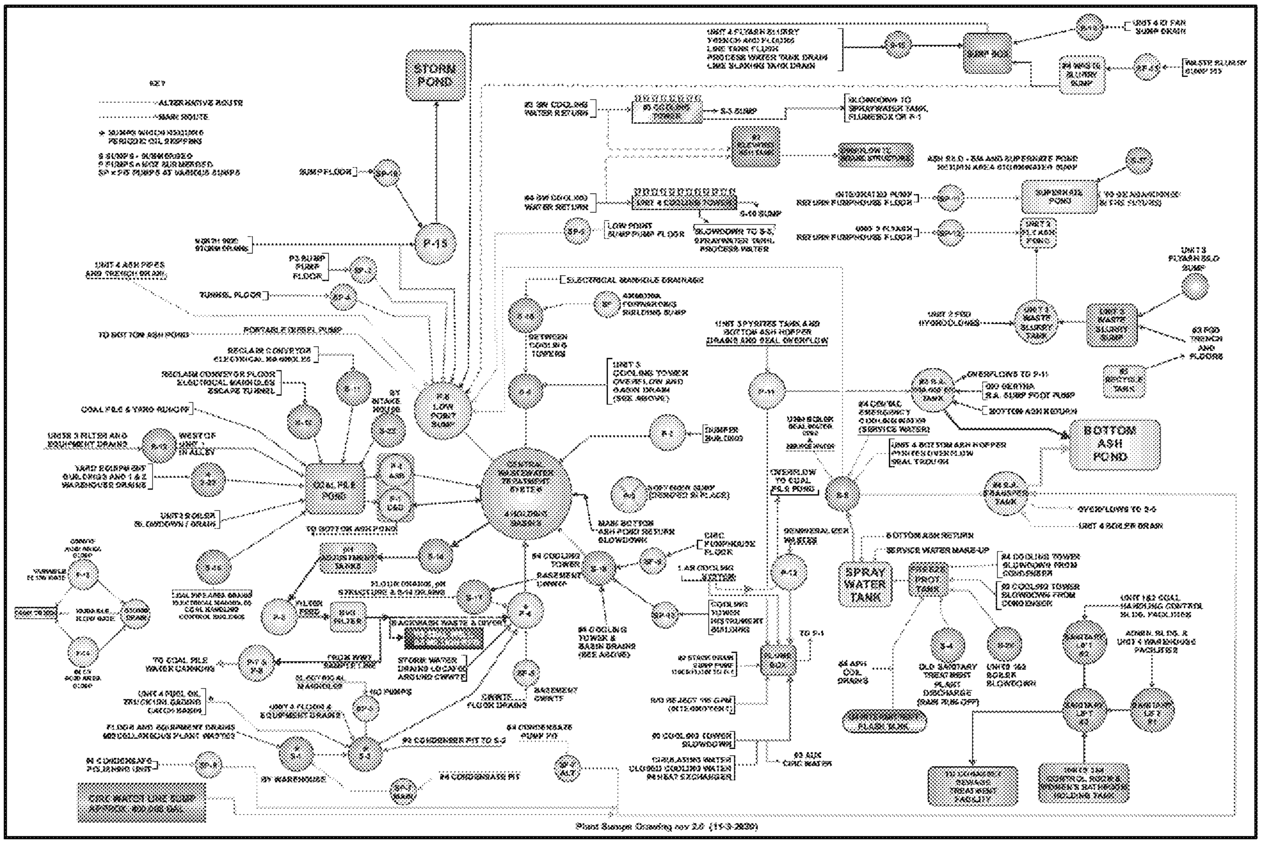

Figure 3. *Wastewater inputs and outlets at the Boswell Energy Center.*

<u>Option 10: No Additional Infrastructure</u>
Bypassing of the BAP pond and forgoing installation of additional infrastructure is not a technically feasible option, for the reasons described below.

This option would send all non-CCR wastewater that currently goes to the BAP directly to the existing sump and water treatment system. Based on an analysis provided by Barr Engineering, this option doesn't provide the surge capacity and settling time necessary during periods of high flow (rain, snowmelt, etc.) that the BAP provides. Without these key elements in place, this alternative would result in conditions that exceed the current flow and treatment capacity of the existing sumps and wastewater treatment facility, leading to non-compliance with the current NPDES permit. Therefore, this option is not technically feasible.

<u>Option 11: Pond Modification</u>
Modifications to existing Wastewater Treatment Facility ponds/basins which are already part of the wastewater treatment facility is not technically feasible, for the reasons described below.

Modification of existing ponds would include expansion (horizontally or vertically, or both) to accommodate the additional capacity needed after discontinuing the use of the BAP. However, an engineering analysis performed by Barr Engineering has determined that horizontal or vertical expansions of existing ponds will not provide the necessary capacity for settling and equalization. Therefore, expansion of existing wastewater ponds is not a technically feasible option.

Option 12: Municipal Wastewater Treatment

Sending non-CCR wastewater streams to a municipal wastewater treatment facility is a technically feasible option; however, this option is expected to take up to February 2023 or longer to implement, significantly longer than the selected option (November 30, 2021).

This option would require separation of CCR materials from a system designed to intermingle CCR and non-CCR wastewaters. As shown in Figure 3, Boswell's interconnected and highly complex wastewater system would require significant investment in engineering studies to isolate piping and tanks and determine wastewater quality and flows for each combination of wastewater flows. As described above, this evaluation would be expected to take a minimum of 30 months. Additional work would be necessary to coordinate with the local wastewater treatment facility for receipt of the wastewater flows while ensuring no disruption to the facility's permit limits. BEC would need to obtain a pre-treatment agreement with the municipality. After the engineering studies to characterize and isolate each of the wastewater streams, permitting with the municipality, based on estimates from Barr Engineering, would be expected to take at least 24 months. The municipality may be required to modify their own NPDES Permit for addition of a new Significant Industrial User (SIU), which would increase the time necessary for BEC's receipt of a final pre-treatment agreement.

In addition to permitting, BEC would need to construct a new lift station to accommodate transfer of the non-CCR wastewater to the treatment facility. Based on engineering estimates this activity would take approximately 20 months to design, procure equipment, and construct. A connection from the municipal force main to the wastewater treatment facility would also be necessary under this alternative. This would require design, permitting (County and State right-of-way, and MPCA sewer extension), public project procurement, and construction of approximately 9 miles of 12-inch diameter high density polyethylene force main along existing right-of-way.

Based on the project steps and anticipated timelines described above, routing non-CCR wastewaters to a municipal treatment facility is not the fastest technically feasible option for ceasing receipt of non-CCR wastewaters at BEC.

Option 13: Existing Tank Use

Utilizing existing tanks at BEC that are no longer used is a technically feasible option; however, this option is expected to take until October 2022 to implement, significantly longer than the selected option (November 30, 2021).

Existing tanks used for this purpose would include some tanks that have been out of service for many years. These tanks would be used to create storage capacity for non-CCR waste streams. Based on MP's evaluation, no individual tank is large enough to replace the storage capacity provided by the BAP. A series of tanks, which are spread out across the site, would need to be plumbed and connected to the plant sump system, and the integrity of all tanks would need to be assessed. Most of the tanks do not have the systems necessary for chemical addition and sludge management, which could require additional time for tank retrofits.

The steps needed for this option include sampling and analysis, engineering design, permitting[8], bidding and contractor selection, repair and retrofit of existing systems, equipment procurement, mobilization and equipment submittal review, and construction and commissioning. The estimated time to complete this option is 22 months, longer than the selected option. Therefore, repurposing existing infrastructure/tanks is not the fastest technically feasible option for ceasing receipt of non-CCR wastewater streams.

Option 14: New Tank(s)

Installing new tanks at BEC's CWWTF is a technically feasible option; however, this option is expected to take until October 2022 to implement, significantly longer than the selected option (November 30, 2021).

The new tank would be designed to have sufficient storage capacity to handle non-CCR wastewater flows. The steps needed for this option are the same as retrofitting the existing tanks, described in Option 13 above, with the addition of one new tank. This includes sampling and analysis, engineering design, permitting, bidding and contractor selection, repair and retrofit of existing systems, equipment procurement, mobilization and equipment submittal review, and construction and commissioning. The estimated time to complete this option is 22 months, longer than the selected option. Therefore, repurposing existing infrastructure/tanks is not the fastest technically feasible option for ceasing receipt of non-CCR wastewater streams.

[8] Permitting of addition of tanks is assumed to involve engineering approval from MPCA rather than a major permit amendment

Option	Disposal Alternatives	Technically Feasible	Permitting (months)	Procurement & Construction (months)	Total Time Necessary (months)	Timeline Start Date (permit application submittal date)	Soonest Possible Cease Receipt Date	Fastest Technically Feasible Option?
Pond 3								
1	Off-Site Wet Hauling	No	-	-	-	-	-	No
2	Off-Site Municipal Wastewater	No	-	-	-	-	-	No
3	Use of Existing Impoundments	No	-	-	-	-	-	No
4	On-Site Landfilling w/ Current Ops	No	-	-	-	-	-	No
5	Existing Tank Use	No	-	-	-	-	-	No
6	Impoundment Retrofit	Yes	12	36-48	48-60	December 2020	December 2024	No
7	New Impoundment	Yes	12-72	18-24	30-96	December 2020	June 2023	No
8(a)	New Tank(s)	Yes	11	12-18	23-30	December 2020	November 2022	No
Selected	FGD Gypsum Dewatering	Yes	11	14	25	April 15, 2020	**May 6, 2022**	Yes
Bottom Ash Pond (BAP)								
1	Off-Site Wet Hauling	No	-	-	-	-	-	No
2	Off-Site Municipal Wastewater	No	-	-	-	-	-	No
3	Use of Existing Impoundments	No	-	-	-	-	-	No
4	On-Site Landfilling w/ Current Ops	No	-	-	-	-	-	No
5	Existing Tank Use	No	-	-	-	-	-	No
6	Impoundment Retrofit	Yes	12	36-48	48-60	December 2020	December 2024	No
7	New Impoundment	Yes	12-72	18-24	30-96	December 2020	June 2023	No
8(b)	New Tank	No	-	-	-	-	-	No
9	New Concrete Basin	Yes	12-72	12-18	24-90	December 2020	December 2022	No
Selected	Dry Ash Conversion	Yes	11	15	26	April 15, 2020	**June 4, 2022**	Yes
Non-CCR Wastewater								
10	No New Infrastructure	No	-	-	-	-	-	No
11	Pond Modification	No	-	-	-	-	-	No
12	Municipal Wastewater Treatment	Yes	24-30	50-60	74-90	December 2020	February 2023	No
13	Existing Tank Use	Yes	6	16	22	December 2020	October 2022	No
14	New Tank(s)	Yes	6	16	22	December 2020	October 2022	No
Selected	New Non-CCR Basin	Yes	6	3-6	12	December 2020	**November 30, 2021**	Yes

Table 3. *CCR and non-CCR Alternative Disposal Analysis Summary*

4.5 Analysis of Adverse Impact to Plant Operations if CCR Surface Impoundments are not Available – *§257.103(f)(iv)(A)(ii)*

Because there are no feasible on-site or off-site alternative to handling FGD and bottom ash, the inability to continue operations of Pond 3 or the BAP (the latter serving both Boswell Units 3 and 4) during the development of alternative disposal capacity would result, at minimum, in a temporary idle of Unit 3 and Unit 4 for 13-14 months. This equates to a loss of 940 MW of capacity to the regional power supply and significant impacts on electric grid reliability.

More specifically at Boswell, the idling of two large coal-fired units (BEC Unit 3 and 4, comprising a total of 940 MW) would have widespread and significant impacts to the regional power supply and reliability of the transmission grid. The facility is located in Cohasset, Minnesota, and is the largest generating station on the power grid over a very large geographical region. The generator provides vital system support to ensure reliable service can be maintained for customers across the entire northern half of Minnesota.

BEC Units 3 and 4 are the only remaining baseload generators in Minnesota Power's system, and in all of northern Minnesota. Idling of the power generation at BEC Units 3 and 4 is expected to have widespread and significant impacts to the regional power supply and Bulk Electric System (BES)[9] reliability of the transmission grid. Both BEC Unit 3 and Unit 4 provide vital support to the BES, and help ensure that reliable electric service can be maintained for customers across the entire northern half of Minnesota. Changes to the facility mode of operations, including temporary idling without the ability to return to service when called upon to support reliability, would require extensive coordination with our Regional Transmission Operator, the Midcontinent Independent System Operator (MISO).

Large generation units have a significant role in supporting the reliability of the transmission grid. To ensure no harm is done to reliability by retiring generation, MISO has a tariff provision and process to study the reliability impacts of any proposed idling or retirement of units operating in its footprint. This process is known as an Attachment Y Study[10] or Attachment Y-2 Study[11] ("Attachment Y Studies"). Any issues identified in the Attachment Y Studies are required to be mitigated prior to idling or retiring the generating unit(s). Correcting system issues related to unit idling or retirement requires either the construction of additional generation capacity or the development of new (and potentially very extensive) transmission infrastructure to restore the reliability provided by the idled or retired unit(s). Both new generation and large transmission projects can expect to take 7-10 years to develop, permit, and construct.

On August 13, 2018, Minnesota Power submitted an Attachment Y-2 Study request to MISO for a transmission system reliability assessment of BEC Unit 3 and Unit 4. MISO's study focused on

[9] The Bulk Electric System (BES) is planned and maintained according to mandatory North American Electric Reliability Corporation (NERC) Standards

[10] The "Attachment Y" study is performed for a generation unit that has committed to idle or retire.

[11] The "Attachment Y-2" study is an information-only study.

various idling/retirement scenarios of BEC Units 3 and 4 individually, as well as a combined BEC 3 & 4 scenario. The study was designed to identify reliability issues due to potential change of operational status at BEC. MISO performed the study following the process set forth in the tariff and MISO Business Practices Manuals. The results were discussed and analyzed with regional Transmission Owners to determine if there are reliability issues due to the change of status at BEC. The results of the analysis identified significant reliability issues caused by the potential change of operations at BEC Unit 3 and 4, both jointly and if separately idled/retired. In the study report, MISO states these reliability issues "…would likely require robust mitigating solutions to be built before the retirements of the unit(s) could be allowed."

Additionally, MISO stated that absent a solution being in place prior to retirement, one or both BEC units may need to be designated as System Support Resource ("SSR") units. The SSR is a status designated to generating units that have requested to retire or idle, but are not allowed to do so because of the impacts expected on the Bulk Electric System. Specifically, idling or retiring would be expected to exceed the allowed magnitude of change allowed by standards set by North American Electric Reliability Corporation ("NERC") and approved by Federal Energy Regulatory Commission ("FERC"). SSR units must continue to have the capability to operate until solution(s) are put in place that mitigate the reliability concerns.

Clearly, a thoughtful transition plan is needed to accommodate a change of operating status for BEC Units 3 and 4. MISO has identified concerns with maintaining regional reliability if there was a cessation of power generation at one or both BEC units prior to transmission system solutions being implemented. Ceasing receipt of CCR by April 2021 via idling the units does not give Minnesota Power sufficient time to complete the required study work, identify and engineer final solutions, and then implement those solutions needed to maintain reliability on the Bulk Electric System to NERC standards. As stated earlier, this process can take several years and solutions could take 7-10 years to implement in this particular situation. Based on the findings in the MISO Attachment Y-2 study, the idling of power generation at BEC Units 3 and 4 will have widespread and significant impacts to the regional power supply and reliability of the transmission grid, thus requiring BEC Units 3 and 4 to operate.

A redacted public version of the MISO Attachment Y-2 report is included in the Appendix D of this document.

5.0 Pond 3 Work Plan – §*257.103(f)(iv)(A)(2)-(3)*

5.1 Project Timeline Justification – §*257.103(f)(1)(ii)(A)(2)*

For Pond 3 this Section a project timeline justification per §257.103(f)(1)(ii)(A)(1) requires:

(2) A detailed schedule of the fastest technically feasible time to complete the measures necessary for alternative capacity to be available including a visual timeline representation. The visual timeline must clearly show all of the following:

> *(i) How each phase and the steps within that phase interact with or are dependent on each other and the other phases;*
> *(ii) All of the steps and phases that can be completed concurrently;*
> *(iii) The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take; and*
> *(iv) At a minimum, the following phases: Engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.;*

The FGD Gypsum Dewatering project is expected to be complete on May 6, 2022. The time necessary for this project includes major modification of the facility Title V Permit which is expected to take 11 months, followed by equipment procurement and project construction which is expected to take 14 months. The permitting timeline was initially determined through discussions with MPCA and supported by the Letter of Concurrence provided in Appendix C, which demonstrates permitting in Minnesota can take anywhere from 9-22.5 months. The project specific permitting timeline was revised in October and November 2020 to reflect the current projection of 11 months from permit application submittal.

The permitting process was initiated in late 2018 by developing preliminary engineering design details to support a permit application and associated air dispersion modeling. The modeling protocol and application for this project was submitted to the MPCA in April 2020, initiating the 15 step permitting process described in Section 1.1. While preliminary engineering and portions of the final design work may be completed during the permitting process, construction cannot begin until a final permit is issued by the MPCA, as required under 7007.1150 Subpart B. Given MP had already initiated preliminary engineering and permitting prior to finalization of the CCR Part A Rule, the requested extension of the cease receipt date for BEC Pond 3 reflects only the necessary time remaining to complete this project.

As detailed in the project timeline and narrative, once a modified permit is received, fabrication of the horizontal belt filter, pumps and conveyors can commence. Construction of the material load out building can begin during fabrication and delivery of the major equipment. Once the equipment is on-site, the conveyor can be connected to the material load out building and installation of the major equipment can occur. Final equipment installation and tie-ins must be completed during a unit outage. The project schedule is aligned to utilize the scheduled and planned spring outage in 2022, which will coincide with dry bottom ash conversion activities. Facility outages are scheduled 2 years in advance and must be approved by MISO. This process is in place to ensure electric generators are not planning outages during times of peak demand (typically during winter months for Boswell) and enough generators are available online to meet energy demands. All phases and steps completed after permit issuance are expected to take no longer than 14 months.

Project timelines developed by MP are based on permitting discussions with MPCA, evaluation of the major project phases and the steps within each phase, evaluation of phases or tasks that can be completed concurrently, and discussions with vendors. Additionally MP vetted timeline estimates and assumptions with external consultants. Although MP has outlined areas of potential delay, timelines presented do not include any additional time for these items. All project timelines are calculated in full calendar days (including weekends) and are represented as such in the narrative discussion. Based on MP's analysis of alternative capacity disposal options, and as supported by the timelines provided in Section 5.2, May 6, 2022 is the fastest date technically feasible to cease the disposal of CCR in Pond 3. A process flow diagram of project installation is provided below in Figure 4.

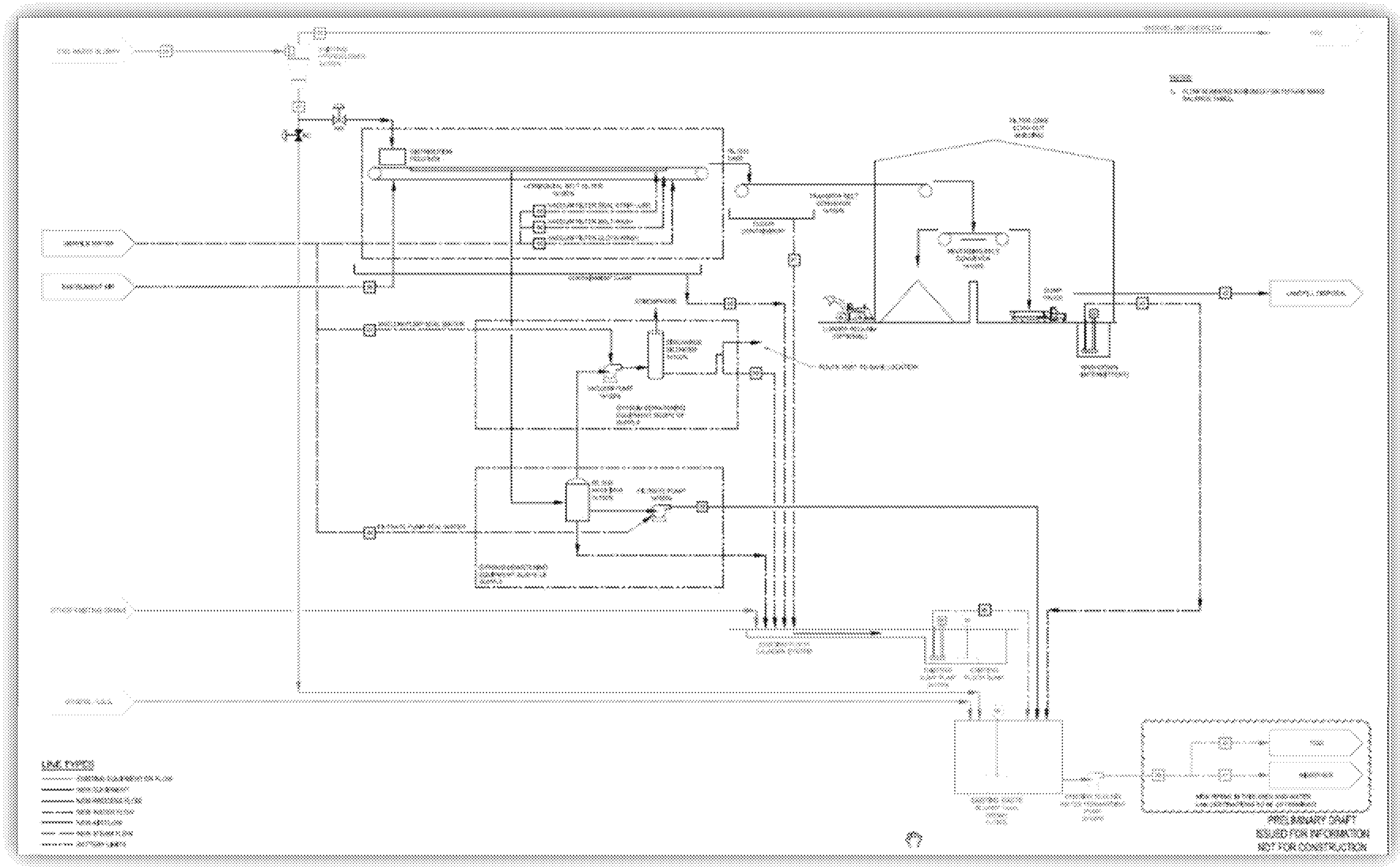

Figure 4. *Unit 3 Installation Process Flow Diagram*

Section 5.2 Gypsum Dewatering Visual Project Timeline - *§257.103(f)(1)(ii)(A)(2)*

ID	Task Name	Duration	Start	Finish
1	**Gypsum Dewatering**	**869 days**	**Fri 12/20/19**	**Fri 5/6/22**
2	**MPCA Air Permitting**	**343 days**	**Fri 4/3/20**	**Thu 3/11/21**
3	Modelling Protocol Submitted	0 days	Fri 4/3/20	Fri 4/3/20
4	Modelling que	19 days	Fri 4/3/20	Tue 4/21/20
5	Modelling Protocol Accepted	0 days	Wed 4/22/20	Wed 4/22/20
6	Modelling Process and Modelling Report Ap	3.1 mons	Wed 4/22/20	Thu 7/23/20
7	Permit Application Submitted	0 days	Wed 4/15/20	Wed 4/15/20
8	MPCA Permitting Que	176 days	Wed 4/15/20	Wed 10/7/20
9	Permit Engineer Assigned	0 days	Wed 10/7/20	Wed 10/7/20
10	MPCA Permitting Process	100 days	Thu 10/8/20	Fri 1/15/21
11	MP Draft Permit Internal Review	10 days	Sat 1/16/21	Mon 1/25/21
12	Public Notice/Review	45 days	Tue 1/26/21	Thu 3/11/21
13	Permit Issuance	0 days	Thu 3/11/21	Thu 3/11/21
14	**Vendor Selection**	**174 days**	**Fri 12/20/19**	**Thu 6/11/20**
15	Request for Bids	29 days	Fri 12/20/19	Fri 1/17/20
16	Bid Evaluation	54 days	Sat 1/18/20	Wed 3/11/20
17	Contract Negotiation	91 days	Thu 3/12/20	Wed 6/10/20
18	Award Contract	0 days	Thu 6/11/20	Thu 6/11/20
19	**Engineering Design**	**384 days**	**Tue 6/16/20**	**Sun 7/4/21**
20	Vendor Design Submittals	384 days	Tue 6/16/20	Sun 7/4/21
21	Preliminary Design	113 days	Wed 9/9/20	Wed 12/30/20
22	Structural Design	28 days	Mon 1/11/21	Sun 2/7/21
23	**Plan Development**	**10 days**	**Mon 1/11/21**	**Wed 1/20/21**
24	Civil Sitework Plans	2 days	Mon 1/11/21	Tue 1/12/21
25	Architectural Plans	4 days	Mon 1/11/21	Thu 1/14/21
26	Concrete Foundation Plans	7 days	Thu 1/14/21	Wed 1/20/21
27	Structural Steel Plans	7 days	Thu 1/14/21	Wed 1/20/21
28	Mechanical	130 days	Sun 11/1/20	Wed 3/10/21
29	Electrical	112 days	Sun 11/1/20	Sat 2/20/21
30	Instrument & Control	112 days	Sun 11/1/20	Sat 2/20/21
31	Design Review	58 days	Tue 12/15/20	Wed 2/10/21
32	Issue for Construction Drawings	23 days	Thu 2/11/21	Fri 3/5/21
33	Installation Specs	98 days	Tue 12/1/20	Mon 3/8/21
34	**Major Component Design**	**56 days**	**Tue 6/16/20**	**Mon 8/10/20**
35	General Arrangement Drawings	4 wks	Tue 6/16/20	Mon 7/13/20
36	Design and Detail Review	1 wk	Tue 7/14/20	Mon 7/20/20
37	Minnesota Power Review	3 wks	Tue 7/21/20	Mon 8/10/20
38	**Contractor Selection**	**47 days**	**Mon 3/1/21**	**Fri 4/16/21**
39	Request for Bids	15 days	Mon 3/1/21	Mon 3/15/21
40	Bid Evaluation	4 days	Tue 3/16/21	Fri 3/19/21
41	Contract Negotiation	28 days	Sat 3/20/21	Fri 4/16/21
42	Award Contract	0 days	Fri 4/16/21	Fri 4/16/21
43	**Procurement & Fabrication**	**147 days**	**Fri 3/12/21**	**Thu 8/5/21**
44	Fabrication Drawings Released	3 wks	Fri 3/12/21	Thu 4/1/21
45	Purchase Ordered Issued	1 wk	Fri 4/2/21	Thu 4/8/21
46	Materials Ordered	2 wks	Fri 3/12/21	Thu 3/25/21
47	Equipment Fabrication	16 wks	Fri 3/26/21	Thu 7/15/21
48	Delivery of Dewatering Equipment	3 wks	Fri 7/16/21	Thu 8/5/21
49	**Construction and Installation**	**340 days**	**Tue 6/1/21**	**Fri 5/6/22**
50	Contractor Mobilize	7 days	Tue 6/1/21	Mon 6/7/21
51	Demolition	14 days	Tue 6/8/21	Mon 6/21/21
52	Excavation	14 days	Tue 6/22/21	Mon 7/5/21
53	Underground Utilities	14 days	Tue 7/6/21	Mon 7/19/21
54	Foundations	21 days	Tue 7/20/21	Mon 8/9/21
55	Structural Steel	24 wks	Tue 8/10/21	Mon 1/24/22
56	Mechanical Systems	36 wks	Tue 8/24/21	Mon 5/2/22
57	Electrical Systems	36 wks	Tue 8/24/21	Mon 5/2/22
58	Pre-Outage Preparation	90 days	Wed 1/5/22	Mon 4/4/22
59	Installation of Dewatering Equipment	32 days	Tue 4/5/22	Fri 5/6/22

5.3 FGD Gypsum Dewatering Timeline Narrative - *§257.103(f)(1)(ii)(A)(3)*

For Pond 3 a timeline narative description per §257.103(f)(1)(ii)(A)(1) requires:

(3) A narrative discussion of the schedule and visual timeline representation, which must discuss all of the following:

(i) Why the length of time for each phase and step is needed and a discussion of the tasks that occur during the specific step;

(ii) Why each phase and step shown on the chart must happen in the order it is occurring;

(iii) The tasks that occur during each of the steps within the phase; and

(iv) Anticipated worker schedules;

The FGD gypsum dewatering project is expected to take approximately 25 months, with the permitting process accounting for 11 months. An additional 14 months is required for the remaining major project phases including equipment vendor selection, design engineering, major component design, contractor selection, fabrication, delivery, and construction.

The primary component of the FGD system will be a vacuum belt filter and supporting infrastructure. The belt filter, consisting of a high strength needle-punched non-woven or similar geotextile, receives the FGD slurry at the slurry feed box. The feed box meters/distributes the slurry onto the belt filter. A vacuum is applied to the underside of the belt filter, to draw the liquid out of the slurry as the filter travels from start point to the discharge chute. Because the filter cloth is porous but with very fine pore size, the FGD solids are retained atop the cloth as the liquid is pulled (filtered) through and collected as filtrate. The cloth type, surface area, travel speed, and vacuum pressure are selected to efficiently remove sufficient liquid from the slurry to produce a dewatered filter cake suitable for transport by truck to and placement in the onsite CCR landfill. The filter cake is removed from the system at the discharge chute, then loaded to a haul truck for on-site transport to the on-site landfill or offsite for beneficial reuse.

5.3.1 Permitting *(343 days)*

A major amendment of BEC's Title V Air Permit is required for both the FGD gypsum dewatering and the dry bottom ash conversion projects. Due to the numerous physical and operational changes associated with this project, there is a potential for increased air emissions of constituents such as particulate matter (PM). For example, PM emissions may be effected by this project given the dewatered CCR material will have a lower moisture content and be placed in a dry landfill, and wet sluicing will be replaced by truck hauling which will result in more truck traffic. Additionally, BEC has a Title V permit condition that requires air dispersion modeling for any increases in PM. According to state[12] and federal[13] requirements, construction of conversion activities needed to cease receipt of CCR cannot commence until the permits required for those changes are issued by the appropriate state or federal regulatory agency, in this case, the MPCA. Therefore, a major amendment of the BEC's Title V Air Permit must be complete for both the gypsum dewatering and dry bottom ash conversion projects before initiating construction.

MP has compiled this variance application request with the most current estimate of the completion date of environmental permitting. Based on correspondence with MPCA air permitting staff on October 7, 2020 and confirmed on November 5, 2020, the MPCA has indicated BEC can expect final air permits for the bottom ash dry conversion and FGD dry conversion in mid-March 2021. This is therefore the date used for securing air permits in the project timelines and represents an 11 month period from application submittal to permit issuance.

Upon issuance and receipt of Boswell's modified air permit, and in conjunction with the local construction season (April-Oct) and outage on each unit, the Unit 3 FGD slurry dewatering system installation will commence.

5.3.2 Vendor Selection *(174 days)*
The vendor selection process for this project was completed on June 11, 2020. This consisted of the following steps with actual completion time in parentheses: request for bids (29 days), bid evaluation (54 days), and contract negotiation and award (91 days). The steps in this process could not be completed concurrently, due to each step's reliance on the results of the previous step. Once the bid request was sent out, contractors were given 29 days to respond. The length of time offered for contractors to respond was based on project complexity. Internal evaluation of the bid responses took 54 days to complete. This allowed time to compare bids and discuss proposal details with each vendor. Contract negotiation time can vary. Based on the complexity of this project the negotiation period took 91days to complete.

5.3.3 Engineering Design *(384 days)*
Engineering design is a necessary component of this project and consists of the following steps: preliminary design of dewatering equipment and material load out building (113 days), structural design of buildings and conveyors (28 days), plan development (10 days), mechanical engineering (130 days), electrical engineering (112 days), instrumentation and controls (112

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[12] Minn. R. 7007.0150. The rule provides that "no person may construct, modify, reconstruct, or operate an emissions unit, emission facility, or stationary source until plans for it have been submitted to the agency and a written permit for it has been granted by the agency. Exceptions to the requirement to obtain a permit are located in part 7007.0300. Exceptions to the requirement to obtain a permit amendment are located in parts 7007.1250 and 7007.1350."*Id.* at 7007.0150(A)

[13]40 C.F.R. §52.21. The rule provides that "[n]o new major stationary source or major modification to which the requirements of paragraphs (j) through (r) (5) of this section apply shall begin actual construction without a permit that states that the major stationary source or major modification will meet those requirements. The Administrator has authority to issue any such permit." *Id.* at §52.21(a) (2) (iii).

days), design review (58 days in total), issuance of construction drawings for bid (23 days), and development of dewatering equipment installation specs (98 days). Design review is performed upon completion of each set of designs. This occurs throughout the engineering design phase, but is represented as the total time necessary.

Steps that can occur concurrently during engineering design are shown on the project timeline Steps that are performed sequentially must be done-so due to reliance on completion of the previous step. The steps in this phase that require the most time are further detailed below.

<u>Preliminary Design</u>
The initial design work consists of incorporating the equipment vendor component design into the overall design plan for underground utility work, foundations, auxiliary and piping connections, electrical connections, controls connections, transfer conveyors, and design of the material load out building.

<u>Plan Development</u>
Plan development includes compilation and drafting of load out building civil site work, load-out building architectural, structural steel, and building & support concrete foundation plans.

<u>Mechanical, Electrical, and Instrumentation and Controls</u>
The mechanical, electrical, and instrumentation and control design can occur concurrently. These steps consist of the development of general arrangements, process flow diagrams, process and instrumentation diagrams, electrical load, piping arrangements, HVAC, foundations, logic diagrams, and control philosophy final design to tie equipment and plant processes together.

<u>Development of Installation Specs</u>
Specifications must be developed to detail equipment parts installation and the specific order of installation.

5.3.4 Major Component Design *(56 days)*
Design of the major equipment components, dewatering equipment and conveyors, requires the development of general arrangement drawings (28 days), design and detail review (7 days), and internal review of design drawings (21 days). The steps in this process cannot be completed concurrently due to each step's reliance on the results of the previous step.

5.3.5 Contractor Selection *(47 days)*
Contractor selection cannot take place until the engineering and design components are complete. This phase consists of the following steps: request for bids (15 days), bid evaluation (4 days), contract negotiation and award of the contract (28 days). The steps in this process cannot be completed concurrently due to each step's reliance on the results of the previous step. Once a bid request is sent out, contractors are given 15 days to respond but may request additional time

as needed. The length of time offered for contractors to respond is based on project complexity. Internal evaluation of the bid responses is estimated to take 4 days to compare bids and discuss proposal details with each contractor. Contract negotiation time can vary, however, MP anticipates this to take approximately 28 days.

5.3.6 Procurement & Fabrication *(147 days)*

In order to ensure the fastest possible cease of receipt of CCR in Pond 3, it is critical that implementation of MP's selected option proceeds smoothly, without significant modifications throughout the course of implementation. One way MP reduces this risk is to achieve a level of regulatory certainty before procurement, fabrication, and construction activities for the FGD dewatering technology.

For FGD dewatering technology, this means MP must ensure the necessary air permits are received, all regulatory requirements are understood, and -- if applicable -- those requirements are communicated to the equipment fabricator and construction contractors prior to work activities. If equipment fabrication and procurement is conducted before regulatory clarity is achieved, there is a significant risk that equipment may need to be altered or the process restarted, which can create supply issues, causing MP to lose its place in the fabrication queue, or cause numerous other issues that would negatively affect the project(s) timeline. Therefore, MP plans to commit to the fabrication and procurement of the FGD equipment after we have secured the required environmental permits.

Once the permit is received fabrication of a vacuum belt filter dewatering and conveyor system will commence via the equipment vendor. Steps in this phase include the release of the final fabrication drawings (21 days), vendor issuance of a purchase order (7 days), vendor material order (14 days), equipment fabrication (112 days), and delivery of the equipment (21 days). Fabrication is required of the major system components consisting of the belt filter, support structure, and pumps. The fabrication work is expected to take place within the United States. The fabrication time and delivery time is based on vendor proposals. The overall length of time necessary for equipment fabrication and delivery is expected to take 147 days, with some activities occurring concurrently.

5.3.7 Construction *(340 days)*

Construction and equipment installation will consist of the following steps: contractor mobilization (7 days), demolition of existing infrastructure and auxiliary systems (14 days), excavation for load out building (14 days), installation of underground utilities (14 days), installation of all underground foundations for the load out building (21 days), installation of all structural steel components (168 days), mechanical systems (252 days), electrical systems (252 days), pre-outage preparation (90 days), installation of dewatering equipment (32 days), and tie in of all electrical and mechanical equipment. Most of the steps in the process must occur sequentially because the material load out building must be nearly complete prior to installation of the transfer conveyors, however installation of the electrical system and dewatering equipment can take place concurrently as shown in the project timeline. Construction of the material load out building and conveyor installation must occur during non-freezing months and the tie-in of major equipment must occur during a unit outage. This results in a total of 340 days to complete construction and installation, accounting for the necessary construction season and time between installation of the major equipment and the scheduled spring outage needed for final system tie-in.

Material Load Out Building

Construction of the material load out building will commence (currently projected as June 2021) while major equipment is being fabricated. The material load out building must be constructed during non-frozen conditions to allow for site grading (14 days), concrete work (21 days), and structural steel installation and framing of the building (168 days). The need for excavation and concrete installation requires frost to be out of the ground and soil and air temperatures warm enough to prevent freezing of poured concrete. In northern Minnesota, these conditions exist only during the timeframe of April-October. From the time the weather cooperates to completion of installation activities, this below grade work is estimated to take approximately 2 months with structural steel being completed in 6 months. It is anticipated that work can occur 7 days a week during daylight hours to complete the necessary outdoor construction activities during non-freezing months.

Conveyor Installation

Installation of the conveyors will commence in parallel to the construction of the storage building. This activity will include the relocation of existing utilities (14 days) and structural steel modifications which are currently estimated to take 168 days. Final conveyor assembly and installation cannot occur until the construction of the material load out building is nearly complete.

Major Equipment Installation

Installation of major dewatering equipment must take place during a Unit 3 outage. This outage is currently scheduled in the spring of 2022. The outage will be used to install the belt filter and all connecting systems including filtrate, dry material, electrical and auxiliary tie-ins. The rationale for utilizing the spring 2022 outage is to align the FGD gypsum dewatering equipment installation with the necessary 4-week outage for dry bottom ash conversion (described in Section 4.0). The total time needed for installation is anticipated to be 32 days, with 7 days needing to occur during an outage. Contractors can be scheduled to work 7 days a week as needed to complete the project.

Start-Up & Commissioning

Once the outage is complete, the gypsum dewatering system will be operational and CCR disposal in Pond 3 will no longer be necessary. Operational tuning will continue to take place for several months after the start-up while the system is operational. Any major adjustments to the system after the outage will require the Unit to shut down.

5.4 Steps Taken to Initiate Pond 3 Closure - *§257.103(f)(1)(ii)(A)(3)*

Minnesota Power conducted early feasibility studies of alternative storage for Pond 3 in late 2016 and 2017 to develop technically feasible storage options in the event that Pond 3 triggered closure under CCR criteria. In October 2018, based on the direction taken by EPA after the USWAG Decision, associated rule remand, and finalized assessment of Pond 3 under the CCR Rule location restrictions, MP initiated efforts to further evaluate the FGD Gypsum Dewatering System. MP proceeded to develop the details necessary to begin permitting activities which included preliminary design. In September 2019 a decision was made by MP to move forward with the FGD gypsum dewatering project.

On October 17, 2019, MP initiated the permitting process by requesting consultant proposals for a permitting applicability analysis. This work was awarded by October 24, 2019. The same consultant was then hired on November 26, 2019, to complete the air dispersion modeling. MP expanded the scope of the work to include preparation of the associated permit application on February 28, 2020. The modeling was complete on April 3, 2020. This process included one week of internal review prior to the finalization of the modeling protocol. Minnesota Power submitted the modeling protocol to the MPCA on April 3, 2020, the same day it was completed. The MPCA accepted the modeling protocol and began to review it on April 22, 2020. A draft permit application was prepared by March 25, 2020. The draft went through several levels of review prior to finalization on April 15, 2020. Minnesota Power submitted a major permit amendment application for the gypsum dewatering and dry bottom ash conversion projects on April 15, 2020. At the time of this submittal, the modeling protocol has received approval from MPCA and the permit application has been assigned to a permit engineer.

MP also proactively took steps to help make the permit reissuance process move expeditiously by engaging tribal resource agencies about planned air permit changes. This included telephone conversations with Fond du Lac and Bois Forte tribal staff on August 11, 2020. Additional technical information was sent to Bois Forte staff via email at their request. MP will continue to engage other stakeholders in the time before draft permit issuance to help ensure a thorough and efficient public review of the air permit amendments.

6.0 BAP Work Plan – §*257.103(f)(iv)(A)*

For BAP a project timeline justification per §257.103(f)(1)(ii)(A)(1) requires:
(2) A detailed schedule of the fastest technically feasible time to complete the measures necessary for alternative capacity to be available including a visual timeline representation. The visual timeline must clearly show all of the following:

(i) How each phase and the steps within that phase interact with or are dependent on each other and the other phases;
(ii) All of the steps and phases that can be completed concurrently;
(iii) The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take; and
(iv) At a minimum, the following phases: Engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.;

6.1 Project Timeline Justification – §*257.103(f)(iv)(A)(2)*

The dry bottom ash conversion project and construction of new non-CCR wastewater storage capacity is expected to be complete June 4, 2022. The time needed for these projects is due to major modification of the facility Title V Permit associated with dry ash conversion, which is expected to take 11 months, and equipment procurement, design and construction activities that are expected to take 15 months. The permitting timeline was determined through discussions with MPCA and is based on the current permitting status, this is also supported by the Letter of Concurrence provided in Appendix C which demonstrates permitting in Minnesota can take anywhere from 9-22.5 months. The project specific permitting timeline was revised in October 2020 and confirmed on November 5, 2020, to reflect the current projection of 11 months after permit application submittal. The permitting process was initiated in late 2018 by developing preliminary engineering design details to support a permit application and associated air dispersion modeling. The modeling protocol and application for this project was submitted to the MPCA on April 15, 2020, initiating the 15 step permitting process described in Section 1.1. While preliminary engineering and portions of the final design work may be completed during the permitting process, construction cannot begin until a final permit is issued by the MPCA as required under 7007.1150 Subpart B. Given MP had already initiated preliminary engineering and permitting prior to finalization of the CCR Part A Rule, the requested extension of the cease receipt date for BEC's BAP reflects only the necessary time remaining to complete this project in conjunction with construction of a new non-CCR wastewater pond.

Once a modified permit is received, fabrication of grinders, submerged grind conveyor, and conveyors can commence. Construction of the material load out building can begin during fabrication. Once the equipment is on-site the conveyor can be connected to the material load out building and installation of the major equipment can occur. Final equipment installation and tie-ins must be completed during an outage. The project schedule is aligned to utilize the spring outage in 2022, which will coincide with FGD gypsum dewatering project activities. All phases and steps completed after permit issuance are expected to take no longer than 15 months.

To address non-CCR wastewater streams, a plant water balance was completed and non-CCR wastewater storage alternatives identified. Based on an evaluation of the alternative options identified, the fastest technically feasible option to cease receipt in the BAP is construction of a new non-CCR wastewater containment basin ("pond"). Because development of a new non-CCR wastewater pond involves a change in wastewater discharge characteristics and construction of new wastewater treatment infrastructure, NPDES permitting changes are required.

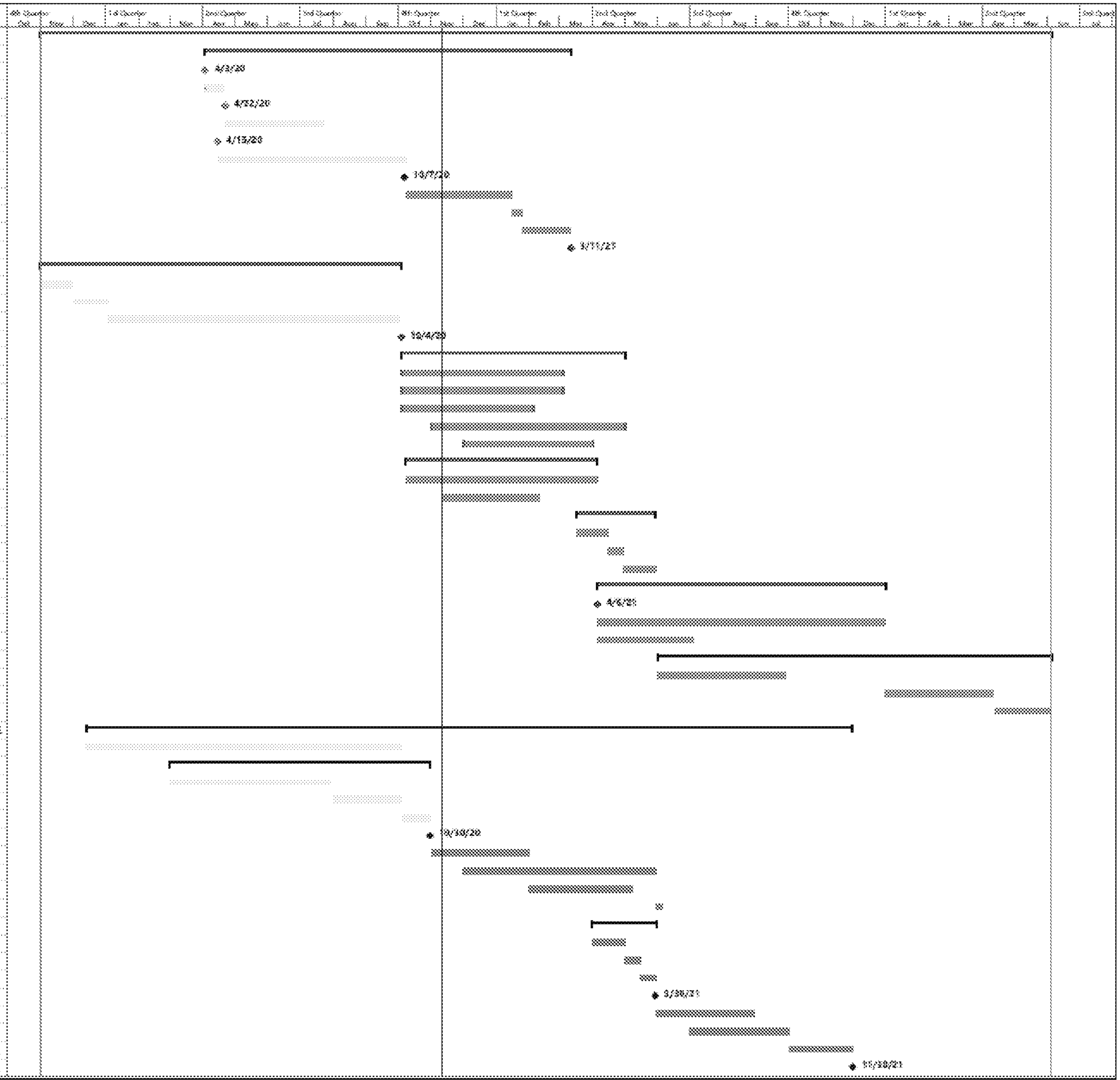
For this demonstration, MP has allotted 6 months for permitting of the non-CCR pond, beginning immediately after engineering design is complete. Additionally, because the new, non-CCR wastewater stream is anticipated to contain lower levels of pollutants and be a reduced volume stream from existing processes (primarily because bottom ash transport water will be eliminated post-dry-conversion), agency approval could be fairly straightforward. Therefore, MP believes this is a reasonable estimate for permitting at this time. However, significant public comments and/or legal challenges for the permit in general could affect this timeline, resulting in longer-than-anticipated timelines for ceasing receipt of non-CCR wastewaters in the Bottom Ash Pond. Estimated permitting timelines are further supported and discussed in Section 1.1.

The timeline for construction of a new non-CCR wastewater pond is 3-6 months based on engineering estimates. Overall, this option is expected to take 12 months to complete. Compared to other options, development of a new non-CCR wastewater pond is the fastest technically feasible solution. The phases, steps, and associated timelines for this project are detailed in the project narrative in Section 6.4.

Project timelines were developed based on permitting discussions with MPCA, evaluation of the major project phases and the steps within each phase, evaluation of phases or tasks that can be completed concurrently, and discussion with vendors. Additionally MP vetted timeline estimates and assumption with external consultants. All project timelines are calculated in full calendar days (including weekends) and are represented as such in the narrative discussion. Based on MP's analysis of alternative capacity disposal options, June 6, 2022 is the fastest date technically feasible to cease the disposal of CCR waste streams in the BAP, with cessation of non-CCR waste streams occurring November 30, 2021. As detailed in Section 6.5, MP has already taken steps to initiate this project. The expected cease receipt date reflects only the remaining time necessary to implement the selected alternatives.

Section 6.2 Dry Bottom Ash Conversion & Non-CCR Wastewater Visual Project Timeline - §257.103(f)(1)(ii)(A)(2)

ID	Task Name	Duration	Start	Finish
1	**Dry Bottom Ash**	**947 days**	**Fri 11/1/19**	**Sat 6/4/22**
2	**MPCA Air Permitting**	**343 days**	**Fri 4/3/20**	**Thu 3/11/21**
3	Modelling Protocol Submitted	0 days	Fri 4/3/20	Fri 4/3/20
4	Modelling que	19 days	Fri 4/3/20	Tue 4/21/20
5	Modelling Protocol Accepted	0 days	Wed 4/22/20	Wed 4/22/20
6	Modelling Process and Modelling Report Approval	3.3 mons	Wed 4/22/20	Thu 7/23/20
7	Permit Application Submitted	0 days	Wed 4/15/20	Wed 4/15/20
8	MPCA Permitting Que	176 days	Wed 4/15/20	Wed 10/7/20
9	Permit Engineer Assigned	0 days	Wed 10/7/20	Wed 10/7/20
10	MPCA Permitting Process	100 days	Thu 10/8/20	Fri 1/15/21
11	MP Draft Permit Internal Review	10 days	Sat 1/16/21	Mon 1/25/21
12	Public Notice/Review	45 days	Tue 1/26/21	Thu 3/11/21
13	Permit Issuance	0 days	Thu 3/11/21	Thu 3/11/21
14	**Vendor Selection**	**338 days**	**Fri 11/1/19**	**Sun 10/4/20**
15	Request for Bids	31 days	Fri 11/1/19	Sun 12/1/19
16	Bid Evaluation	32 days	Mon 12/2/19	Thu 1/2/20
17	Contract Negotiation	273 days	Fri 1/3/20	Thu 10/1/20
18	Issue Contract	0 days	Sun 10/4/20	Sun 10/4/20
19	**Engineering Design**	**210 days**	**Sun 10/4/20**	**Sat 5/1/21**
20	Civil Design	152 days	Sun 10/4/20	Thu 3/4/21
21	Structural Design	152 days	Sun 10/4/20	Thu 3/4/21
22	Mechanical & Process Design	124 days	Sun 10/4/20	Thu 2/4/21
23	Electrical Design	182 days	Sun 11/1/20	Sat 5/1/21
24	Instrument & Control Design	122 days	Tue 12/1/20	Thu 4/1/21
25	**Major Component Design**	**180 days**	**Thu 10/8/20**	**Mon 4/5/21**
26	Major Ash Equipment Design	180 days	Thu 10/8/20	Mon 4/5/21
27	Building Design	3 mons	Thu 11/12/20	Tue 2/9/21
28	**Contractor Selection**	**74 days**	**Wed 3/17/21**	**Sat 5/29/21**
29	Request for Bids	1 mon	Wed 3/17/21	Thu 4/15/21
30	Bid Evaluation	14 days	Fri 4/16/21	Thu 4/29/21
31	Contractor Negotiation	1 mon	Fri 4/30/21	Sat 5/29/21
32	**Procurement**	**270 days**	**Tue 4/6/21**	**Fri 12/31/21**
33	Begin Fabrication	0 days	Tue 4/6/21	Tue 4/6/21
34	Major Equipment Fabrication and Delivery	9 mons	Tue 4/6/21	Fri 12/31/21
35	Building Procurement	3 mons	Tue 4/6/21	Sun 7/4/21
36	**Equipment Installation**	**369 days**	**Tue 6/1/21**	**Sat 6/4/22**
37	Bunker Construction	4 mons	Tue 6/1/21	Tue 9/28/21
38	Pre-Outage Preparation	100 days	Sat 1/1/22	Sun 4/10/22
39	Equipment Installation	53 days	Wed 4/13/22	Sat 6/4/22
40	**Non-CCR Wastewater**	**718 days**	**Sat 12/14/19**	**Tue 11/30/21**
41	Wastewater Characterization Study/Site Water Balance	296 days	Sat 12/14/19	Sun 10/4/20
42	**Alternative Identification**	**244 days**	**Sun 3/1/20**	**Fri 10/30/20**
43	Define Alternatives	151 days	Sun 3/1/20	Wed 7/29/20
44	Refine Alternatives	64 days	Sun 8/2/20	Sun 10/4/20
45	Evaluate Alternatives	26 days	Mon 10/5/20	Fri 10/30/20
46	Choose Alternative	0 days	Fri 10/30/20	Fri 10/30/20
47	Engineering Design	91 days	Mon 11/2/20	Sun 1/31/21
48	Permitting	6 mons	Tue 12/1/20	Sat 5/29/21
49	Prepare Final Design & Construction Bid Package	97 days	Mon 2/1/21	Sat 5/8/21
50	Incorporate Permit Requirements Into Final Design	7 days	Sun 5/30/21	Sat 6/5/21
51	**Contractor Selection**	**60 days**	**Thu 4/1/21**	**Sun 5/30/21**
52	Request for bids	30 days	Thu 4/1/21	Fri 4/30/21
53	Bid Evaluation	15 days	Sat 5/1/21	Sat 5/15/21
54	Contract Negotiation	15 days	Sun 5/16/21	Sun 5/30/21
55	Award Contract	0 days	Sun 5/30/21	Sun 5/30/21
56	Construction	93 days	Sun 5/30/21	Mon 8/30/21
57	Plant Upgrades	93 days	Thu 7/1/21	Fri 10/1/21
58	Commissioning	60 days	Sat 10/2/21	Tue 11/30/21
59	Placed in Service	0 days	Tue 11/30/21	Tue 11/30/21



6.3 Dry Bottom Ash Conversion Timeline Narrative-*§257.103(f)(1)(ii)(A)(3)*

Multiple steps are required to convert a wet bottom ash handling system to dry ash handling, including engineering and equipment design, installation of new clinker grinders and a submerged drag chain conveyor for each unit, installation of the transfer conveyor from the submerged drag chain conveyor to the bunker; bunker excavation and installation of foundations and structural steel. These primary components of the dry bottom ash conversion are shown on Figures 5 and 6. While dry bottom ash conversion will eliminate the need for disposal of CCR in the Bottom Ash Pond, the construction of additional storage capacity is also necessary to handle the facility's non-CCR wastestreams.

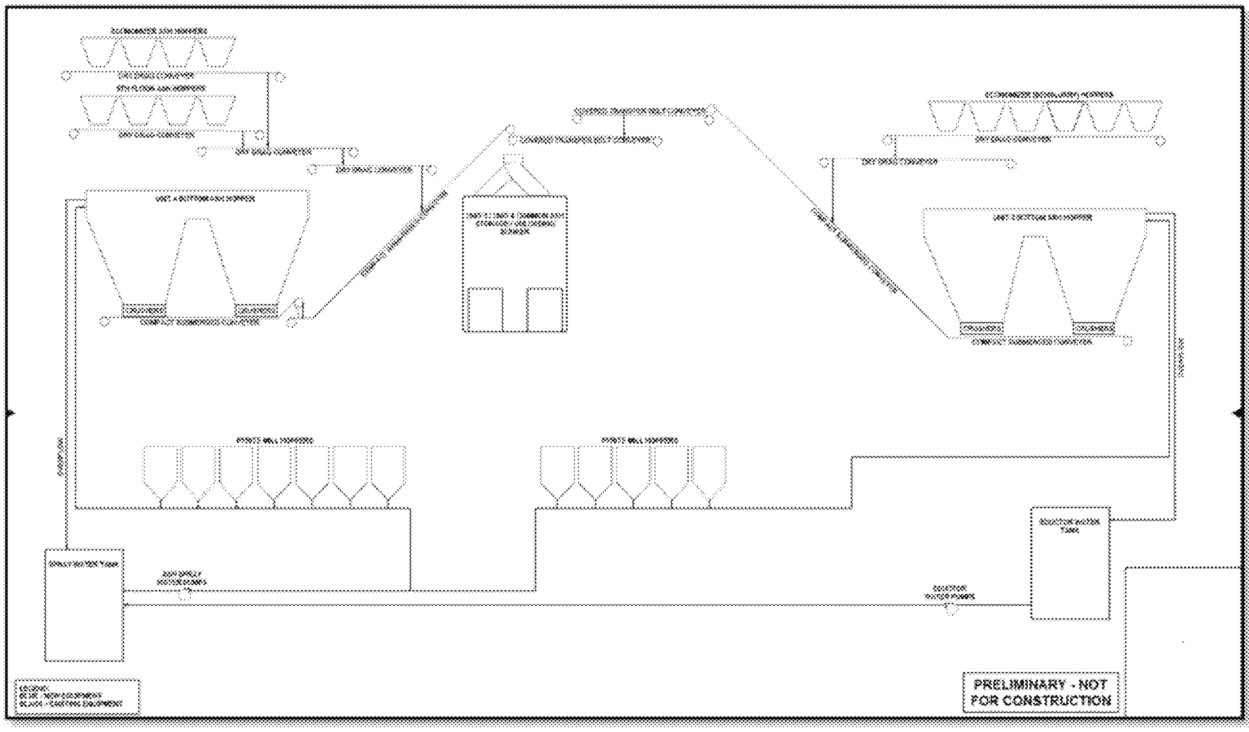


Figure 5. *Dry Bottom Ash Conversion Process Flow Diagram*

6.3.1 Permitting *(343 days)*

The dry bottom ash conversion project is included in the same Title V Permit major modification as the gypsum dewatering project. The length of time and steps required for permitting are the same as those described for Pond 3 (Section 5.3) and are represented as such on the project timeline. This permitting process is expected to take 11 months from the date of application submittal. Again, permitting timelines further discussed in section 1.1.

6.3.2 Vendor Selection *(338 days)*
The vendor selection process for this project was completed on October 1, 2020[14]. This consisted of the following steps with actual completion time in parentheses: request for bids (31 days), bid evaluation (32 days), contract negotiation and award of contract (273 days). The steps in this process could not be taken concurrently. Once the bid request was sent out contractors were given 31 days to respond. The length of time offered for contractors to respond was based on project complexity. Internal evaluation of the bid responses took 32 days. This provided time to compare bids and discuss proposal details with each vendor. Contract negotiation time can vary, given the complexity of the project. There were various factors outside of MP's control that led to the length of time required for contract negotiations including disruptions from COVID-19 and numerous vendor staffing transitions. Negotiations were further complicated by contract provisions related to the estimated timing of the permit issuance which impact schedules with the vendor.

6.3.3 Engineering Design *(210 days)*
Project engineering requires civil design (152 days), structural design (152 days), mechanical and process design (124 days), electrical design (182 days), and instrument and control design (122 days). These steps can overlap and occur concurrently at times as shown on the project timeline. During the engineering design phase, the procurement of any additional equipment needed for the final installation will also occur.

Civil Design
Consists of incorporating the equipment vendor component design into the overall design plan for underground utility work, foundations, and design of the material load out building.

Mechanical, Electrical, and Instrumentation and Controls
The mechanical, electrical, and instrumentation and control design can occur concurrently. These steps consist of the development of general arrangements, process flow diagrams, process and instrumentation diagrams, electrical load, piping arrangements, HVAC, conveyors and material load out building, logic diagrams, and control philosophy final design to tie equipment and plant processes together.

6.3.4 Major Component Design *(180 days)*
This phase can occur at the same time as design engineering and consists of designing major ash handling equipment (180 days), and building design (90 days). The steps in this phase may overlap as shown on the project timeline.

[14] The timeline estimate for this date in Section 6.2 was October 4, 2020, a Sunday. The selection of the vendor three days earlier on October 1, 2020 (a Thursday) is not anticipated to affect overall timelines, and schedules were not adjusted accordingly.

Major Ash Equipment Design
This step consists of a submerged grind conveyor, grinder, economizer conveyor, belt conveyor, and associated piping, valves, and pump design.

Building Design
Development of the material load-out design including underground, piling design, foundation, concrete, and steel framing.

6.3.5 Contractor Selection *(74 days)*
Contractor selection cannot take place until the engineering and design components are complete. This phase consists of the following steps: request for bids (30 days), bid evaluation (14 days), contract negotiation (30 days), and award of the contract (0 days). The steps in this process cannot be taken concurrently. Once a bid request is sent out, contractors are given 30 days to provide a response, but may request additional time as needed. The length of time offered for contractors to respond is based on project complexity. Internal evaluation of the bid responses is estimated to take 14 days to provide time to compare bids and discuss proposal details with each vendor. Contract negotiation time can vary, however, MP anticipates this to take 30 days.

6.3.6 Procurement & Fabrication *(270 days)*
In order to ensure the fastest possible cease of receipt of Bottom Ash in the BAP, it is critical that implementation of MP's selected option proceeds smoothly, without significant modifications throughout the course of implementation. One way MP reduces this risk is to achieve a level of regulatory certainty before procurement, fabrication, and construction activities for the bottom ash dewatering technology.

This means MP must ensure the necessary air permits are received, all regulatory requirements are understood, and -- if applicable -- those requirements are communicated to the equipment fabricator and construction contractors prior to work activities. If equipment fabrication and procurement is conducted before regulatory clarity is achieved, there is a significant risk that equipment may need to be altered or the process restarted, which can create supply issues, cause MP to lose our place in the fabrication queue, or cause numerous other issues that would negatively affect the timeline of the project(s). Therefore, MP plans to commit to the fabrication and procurement of the bottom ash dewatering project after we have secured the required environmental permits.

Once the permit is received fabrication of the clinker grinders and submerged drag chain conveyor will commence via the equipment vendor. Steps in this phase include the release of the final fabrication drawings, vendor issuance of a purchase order, vendor material order, and equipment fabrication and delivery (total of 9 months). Fabrication is required of the major system components consisting of grinders, submerged grinder conveyor, conveyor, transfer chute, and economizer ash conveyor piping. The fabrication work is expected to take place in the United States. The fabrication time and delivery time is based on vendor proposals.

6.3.7 Construction *(369 days)*
Project construction/equipment installation can be broken into 2 stages: pre-outage construction and outage construction. Pre-outage construction will begin once the facility Title V air permit is issued and pending suitable weather. This work includes the construction of the bunker and conveyor systems, which will likely begin at the same time as the equipment fabrication. This activity will include the relocation of existing underground utilities (10 days), piling and foundation installation (40 days), bunker containment concrete installation (23 days), conveyor assembly and installation (27 days), and building enclosure and steel (27 days). Excavation and concrete installation require frost to be out of the ground and soil conditions and air temperatures warm enough to prevent freezing of poured concrete. In northern Minnesota, these conditions exist during the timeframe of April-October. From the time of suitable weather conditions to completion of installation activities, this step is estimated to be completed in 4 months. To assure completion during non-freezing months, contractors can work 7 days a week during all daylight hours to complete the installation.

In addition to the construction of the material load out building, any additional work that can occur, but not interfere with demolition and removal of existing equipment or installation of the new equipment, will occur before the 2022 outage. This would consist of piping installation, cable tray installation and steel support installation.

<u>Equipment Installation</u>
Each unit will need to be taken off-line for a tie-in outage. Work that will be completed during the outage time is demolition and removal of the existing bottom ash equipment, changes to existing systems, demolition and reconstruction of the existing bottom ash pit, and installation of the new clinker grinders and submerged drag chain conveyor. A 4-week outage is needed for each unit to complete these tasks. Contractors can work 7 days a week as needed to complete the project.

<u>Start-Up & Implementation</u>
Once bottom ash upgrades on both units are complete, at the end of the last outage, the systems will be operational and CCR material will no longer be disposed of in the BAP. Operational tuning will continue to take place for several months after the start-up while the system is operational. Any major adjustments to the system after the outage will require the units to shut down.

6.4 Non-CCR Wastewater Timeline Narrative - *§257.103(f)(1)(ii)(A)(3)*

6.4.1 Wastewater Characterization and Water Balance Evaluation *(296 days)*
The development of an updated facility water balance and wastewater characterization study was initiated in November 2019 to develop alternatives that would allow the facility to cease receipt of non-CCR wastewater in the BAP as soon as technically feasible. A detailed facility water balance diagram must be developed to evaluate current non-CCR wastewater flows and volumes throughout the facility and ultimately determine the capacity needed to manage non-CCR

wastewater after ceasing receipt in the BAP. These steps have been completed and the timeline is further discussed in Section 6.5 below, Steps Taken to Initiate Closure.

6.4.2 Engineering Design *(91 days)*

Preliminary design of a new basin includes collecting topographic data via ground survey or drone in the location of the preferred alternative, locating and identifying existing infrastructure in the vicinity of the project, designing the earthwork excavation and fill grades to accommodate the needed storage, and determining pumps, pipes, electrical connections, and controls needed to construct and operate a pond. MP has retained a design consultant to assist with and develop the preliminary design, plan drawings, and specifications for material and installation. Based on discussions with the consultant, it is anticipated engineering and design will take approximately 91 days to complete.

6.4.4 Permitting (*180 days)*

Once the preliminary design is developed, the MPCA will be engaged to initiate permitting discussions for the proposed pond and infrastructure. Based on previous discussions with the MPCA, improvements needed for wastewater storage will likely be approved by modifying the existing NPDES permit, which would include reissuance of the permit. The time needed for NPDES permitting is expected to take 6 months as described in detail in the Alternative Capacity Analysis & Selection section, "NPDES Permitting" and Table 2.

Concurrent with permitting, evaluation of the preliminary design will occur, vetting all operational, maintenance, and construction components of the project. Any concerns or deficiencies identified by operational staff will then be incorporated into the final design. Major changes from the preliminary design, if any, will be brought to the MPCA to be incorporated into the permitting discussions. After the NPDES permit approval is granted, final details and changes to comply with the permit conditions, if any, will be incorporated into the final design.

6.4.5 Contractor Selection *(60 days)*

Once the design is finalized, construction bid documents can be developed incorporating the final design drawings, construction specifications, and bid form. Contractor selection cannot take place until the engineering and design components are complete. This phase consists of the following steps: request for bids (30 days), bid evaluation (15 days), contract negotiation (15 days), and subsequent award of the contract. The steps in this process cannot be taken concurrently. Once a bid request is sent out, contractors are given 30 days to provide a response, but may request additional time as needed. The length of time offered for contractors to respond is based on project complexity. Internal evaluation of the bid responses is estimated to take 15 days, providing time to compare bids and discuss proposal details with each vendor. Contract negotiation time can vary, however, MP anticipates this to take 30 days.

6.4.6 Construction and Plant Infrastructure Upgrades *(93 days)*

After the contract is awarded, the construction contractor will mobilize equipment and materials to the site and begin construction. Construction activities are expected to include clearing and site preparation (5 days), stripping topsoil and/or coal, excavation and grading to develop proposed design grades (45 days), installation of a liner system (10 days), piping (30 days), stormwater controls, and final restoration of disturbed and newly constructed areas (3 days).

During construction of the new wastewater storage pond, any required upgrades or improvements to the plant sump system, piping, controls, and electrical infrastructure needed to utilize the new pond will be installed. Based on engineering estimates the duration of these tasks are expected to take 93 days, with some steps occurring concurrently.

6.4.7 Testing and Commissioning *(60 days)*
Once construction is complete, MP must submit a report to the MPCA documenting all construction activities were completed in accordance with the permit conditions. Upon receipt of MPCA approval of the construction documentation report, the pond will be placed into service and filled. MP will need to perform water balance testing to ensure the liner system is functioning. Based on MPCA's water balance testing criteria this will take a minimum of 30 days. Equipment and pumps will be operated to confirm all controls and components are working as designed and troubleshoot equipment to confirm reliable operation of the pond and all associated controls (30 days). These steps cannot be conducted concurrently given the pond levels must be closely monitored daily during the water balance test and operation/testing of the systems would cause pond levels to fluctuate. Once all systems have been tested and confirmed to be operating as designed, the pond will be placed in service and non-CCR waste streams will be routed to the new containment basin.

6.5 Steps Taken to Initiate BAP Closure - *§257.103(f)(1)(ii)(A)(3)*

6.5.1 Dry Ash Conversion
Minnesota Power conducted early feasibility studies of alternative storage for the BAP in 2016 and 2017 to develop technically feasible storage options in the event that the BAP triggered closure under CCR criteria. In October 2018, based on the direction taken by EPA after the USWAG Decision and associated rule remand, MP initiated efforts to further evaluate dry bottom ash conversion on Units 3 and 4. MP proceeded to develop the details necessary to begin permitting activities which included preliminary design. In September 2019 a decision was made by MP to move forward with the dry bottom ash conversion project.

In combination with the FGD gypsum dewatering project, MP initiated the permitting process on October 17, 2019, by requesting consultant proposals for a permitting applicability analysis. This work was awarded by October 24, 2019. The same consultant was then hired on November 26, 2019, to complete the air dispersion modeling. MP expanded the scope of the work to include preparation of the associated permit application on February 28, 2020. The modeling was complete on April 3, 2020. This process included one week of internal review before the finalization of the modeling protocol. Minnesota Power submitted the modeling protocol to the Minnesota Pollution Control Agency (MPCA) on April 3, 2020, the same day it was completed. The MPCA accepted the modeling protocol and began to review it on April 22, 2020. A draft permit application was prepared by March 25, 2020. The draft went through several levels of review before finalization and submittal on April 15, 2020. Minnesota Power submitted the major permit amendment application for the dry bottom ash conversion and gypsum dewatering projects on April 15, 2020. At the time of this submittal, the modeling protocol has received approval from MPCA and the permit application has been assigned to a permit engineer.

The bidding and vendor selection process for this project was initiated in December 2019. A vendor was selected by Minnesota Power on October 1, 2020. With the equipment vendor selection process complete, MP is currently completing detailed design.

6.5.2 Non-CCR Wastewater Storage

Minnesota Power has completed an updated water balance of the plant and is currently in the process of designing a new non-CCR wastewater management system. Development of the water balance and alternative options was initiated in November 2019 when a consultant was hired to assist with this task. The water balance and non-CCR wastewater storage analysis were finalized in early October of 2020. Development of a new non-CCR wastewater pond was determined to be the fastest technically feasible alternative shortly thereafter.

MP understood the importance of NPDES permitting in the alternatives evaluated, and proactively approached the MPCA permitting staff on January 8, 2020 in MPCA's St. Paul, MN offices. During this meeting, MP conveyed known and likely CCR regulatory drivers, and sought to clarify what steps MP could take to allow efficient permitting for any changes needed at BEC. On March 8, 2020, MP staff, along with other Minnesota utilities and waste managers, again met with MPCA staff in St. Paul to discuss CCR regulations and impacts to state permitting. Shortly thereafter, environmental permitting staff for both MP and MPCA entered remote work conditions due to COVID-19.

Since then, MP has worked closely with the MPCA on a remote basis to understand what updated information and application materials MPCA needs to process the reissuance permit and modification. In a meeting on August 25, 2020, MP staff again conveyed our plans for eliminating wet handling and storage of CCR at BEC, which would result in reduced contaminant load in the NPDES permitted Outfall SD004, since bottom ash transport water will no longer be discharged. MP staff also indicated that the elimination of the BAP would likely necessitate the need for alternate wastewater settling and equalization infrastructure at BEC, and that MP was evaluating various options. This included the eventual option selected, the new non-CCR wastewater settling and equalization basin.

With the understanding that alternate wastewater settling and equalization infrastructure option had not yet been selected, MPCA requested a complete updated reissuance application for BEC at the August 25, 2020 meeting. MP formally initiated permit reissuance work on August 31, 2020, and intends to have the NPDES application submitted to the MPCA by December 2020.

7.0 Additional Compliance Demonstration Required – §*257.103(B)(2)-(8)*

To demonstrate that the criteria in paragraph (f)(1)(iii) of this section have been met, the owner or operator must submit all of the following:

(*1*) A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart; See Section 8.0.

(*2*) Visual representation of hydrogeological information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:

(*i*) Map(s) of groundwater monitoring well locations in relation to the CCR unit(s); See Appendix A

(*ii*) Well construction diagrams and drilling logs for all groundwater monitoring wells; See Appendix A

(*iii*) Maps that characterize the direction of groundwater flow accounting for seasonal variations; See Appendix A

(*3*) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event; See Appendix A

(*4*) A description of site hydrogeology including stratigraphic cross-sections; See Appendix A

(*5*) Any corrective measures assessment conducted as required at §257.96; Boswell has not exceeded any Appendix IV groundwater protection standards and therefore has not conducted any corrective measure assessments.

(*6*) Any progress reports on corrective action remedy selection and design and the report of final remedy selection required at §257.97(a); Boswell has not exceeded any Appendix IV groundwater protection standards and therefore is not in corrective action.

(*7*) The most recent structural stability assessment required at §257.73(d); and See Appendix B

(*8*) The most recent safety factor assessment required at §257.73(e). See Appendix B

8.0 Owner Certification of Compliance – §*257.103(f)(1)(iv)(B)(1)*

In accordance with 40 C.F.R. §257.103(f)(1)(iv)(B)(1), I hereby certify, based on information provided to me by persons immediately responsible for compliance with the CCR Rule at Minnesota Power - Boswell Energy Center, that Boswell's CCR surface impoundments are in compliance with 40 §C.F.R 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. All required CCR compliance documentation is available on Minnesota Power's public CCR Website.

Josh Skelton
VP – Generation Operations & ALLETE Safety

DATE: November 16, 2020

Appendix A

BARR

Boswell Energy Center Coal Combustion Residual Surface Impoundments

Site Hydrogeology

Prepared for
Minnesota Power

November 2020

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Boswell Energy Center

Site Hydrogeology

November 2020

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Acronyms

Acronym	Description
BEC	Boswell Energy Center
CCR	Coal Combustion Residuals
MP	Minnesota Power
USGS	United States Geological Survey

1.0 Introduction and Objectives

Minnesota Power (MP) operates Boswell Energy Center (BEC) in Cohasset, Minnesota. MP operates two coal-fired units at BEC, resulting in production of coal combustion residuals (CCR). CCR at BEC were managed in a three-impoundment system consisting of the Unit 3, Unit 4, and Bottom Ash Surface Impoundments and an onsite CCR landfill. A closed surface impoundment, the Old Bottom Ash Surface Impoundment, is south of the active surface impoundments at BEC (Figure 1). The Unit 4 Surface Impoundment is inactive. CCR management is subject to Federal Standards for Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments per 40 CFR 257 Subpart D (CCR Rule).

The overall objective of this document is to present a summary of the geologic and hydrogeologic conditions and supporting information for the BEC CCR surface impoundment system. This document has been prepared by Senior Hydrogeologist Jere Mohr and Professional Engineer (Geotechnical) Tom Radue, both of Barr Engineering Company, Duluth, MN and Minneapolis, MN, respectively.

2.0 Site Location and Regional Geologic and Hydrogeologic Setting

2.1 Site Description and Location

BEC is located on the west side of Cohasset, Minnesota, between US Highway 2 and the Mississippi River (Figure 1). The operating impoundment system is comprised of the Unit 3, Unit 4, and Bottom Ash Surface Impoundments (collectively referenced below as the CCR impoundment, or impoundments). The impoundments are located near natural waterbodies, the largest of which is Blackwater Lake to the south, a widening of the Mississippi River. Blackwater Lake is approximately 3,000 to 300 feet south of the Unit 3 and Bottom Ash Surface Impoundments, respectively. Wetland complexes are present northwest and northeast of the CCR impoundment. Blackwater Creek is approximately 2,000 feet northeast and east of the Unit 4 Surface Impoundment before flowing into Blackwater Lake approximately 300 feet east of the Bottom Ash Surface Impoundment.

2.2 Regional Geologic and Hydrogeologic Setting

BEC is located within the Superior Upland portion of the Canadian Shield physiographic province. The region is characterized by low hills and rocky ridges formed by exposed Precambrian metamorphic and igneous rocks and thick, recent glacial deposits. Locally, the surficial geology consists of Pleistocene age glacial till, outwash, and lacustrine deposits, along with Holocene age deposits of peat and fluvial sediment associated with the Mississippi River and its tributaries (Hobbs and Goebel, 1982). Unconsolidated surficial sediment overlying bedrock in the area is approximately 150 to over 250 feet thick (Oakes and Bidwell, 1968).

The bedrock formation underlying the surficial deposits consists of Archean age granitic rocks associated with the Giants Range Batholith (Jirsa et al., 2011). Granitic rock was encountered at the site at a depth of 265 feet during a site geotechnical exploration in 1976 (Ebasco, 1977a; 1977b; 1978).

The surficial deposits in the vicinity of the site are mapped as glacial till composed of ground moraine and end moraine deposits, outwash deposits, and lacustrine deposits or glacial lake modified till deposits (Oakes and Bidwell, 1968; Hobbs and Goebel, 1982). Pleistocene age glacial deposits in the region consist of deposits associated with the southwest advance of the Rainy Lobe glaciation and outwash materials overlain by glacial till and outwash deposits associated with the southeastern advance of the St. Louis Sublobe of the Des Moines Lobe glaciation. Lacustrine deposits and lake modified till are associated with Glacial Lake Aitkin that formed during the retreat of the Des Moines Lobe.

The United States Geological Survey (USGS) prepared a groundwater flow model for a region of approximately 114 square miles surrounding Grand Rapids, Minnesota, to simulate groundwater flow in the glacial material (Jones, 2004). BEC is located within the western portion of the model area. The USGS separated the glacial deposits in the region into three generalized glaciofluvial (outwash and fluvial sediments) aquifers separated by regionally extensive clayey glacial till deposits. The three aquifer layers were termed the upper aquifer, middle aquifer, and lower aquifer. The upper aquifer was present at the ground surface and the lower aquifer was overlying bedrock.

3.0 Site Data Compilation

Information to evaluate geologic and hydrogeologic subsurface conditions at BEC was obtained from logs of soil borings that were advanced at the property for different reasons since the 1970s. The primary activities conducted at BEC that included soil borings were:

- the geotechnical investigation conducted as part of the CCR impoundment design and construction planning;
- installation of monitoring wells for the National Pollution Discharge Elimination System (NPDES) / State Disposal System (SDS) Permit; and
- monitoring wells and soil borings advanced to certify the monitoring well network for CCR monitoring.

Locations of the borings used for the geologic evaluation are shown on Figure 2.

3.1 Geotechnical Borings for Impoundment Construction Planning and Monitoring Wells in NPDES/SDS Network

Extensive site exploration was conducted by Ebasco Services Inc. during CCR impoundment design and construction (Ebasco, 1977a; 1977b; 1977c). However, the exploration drilling was primarily for geotechnical purposes and did not include continuous sampling. Soil sampling from these borings was conducted with an 18-inch-long split-barrel sampler at 5-foot vertical sampling intervals, which is consistent with practices for this type of investigation. Multiple field personnel apparently logged soil borings over the course of the investigation, and boring logs appeared to be prepared with varying levels of detail and types of information, with some logs prepared by the drilling contractor, and other logs prepared by an engineer or geologist.

Additional geologic data at the site were obtained as monitoring wells were installed in the late 1970s and through the 1980s. Some of the monitoring well logs do not include geologic descriptions, so surrounding borings and recent survey data were used to infer the deposits in which these wells are screened.

Boring logs and well construction forms are not presented in this report for all wells and borings at the property. Boring logs and well construction forms for the borings and wells described in this section were presented in previous reports (Ebasco, 1977a; 1977b; 1977c).

3.2 Review of Boring Logs for Use in Cross-Section Preparation

Geologic descriptions from each of the existing and new boring logs were compiled as broad lithologic categories of sand, silty sand, clayey sand, silt, and clay, and imported into three-dimensional visualization software used for cross-section layout and scaling. As described above, the amount of detail varied greatly between logs. Many of the boring logs provided interpretations of samples categorized into soil type sequences, while other logs provided only a short description of the samples.

Graphical representations of the boring logs using the broad lithologic categories were used to develop the preliminary cross-sections to evaluate the geologic and hydrogeologic conditions at BEC. The graphical logs of all borings along a cross-section line were included as part of the cross-section construction. The lithologic categories for adjacent boring logs did not always match, which is expected in areas where glacial till, outwash, and lenses of various lithologies are present. Where there are conflicts in information, generally data from newer borings with continuous sampling carried greater weight for evaluating geologic contacts than older borings with discontinuous sampling intervals and less detailed boring logs. Hydrostratigraphic units (described further in Section 4.3), as opposed to individual lithologies, are shown on the cross-sections. Not all potential lenses of geologic materials that are different than the dominant material of the hydrostratigraphic units are drawn on the cross-sections.

3.3 Laboratory Testing of Soil Samples

Soil samples were collected for grain size analysis from boreholes for water level confirmation and/or monitoring wells from the depths where the screens were installed. Additional grain size samples were also collected from borings. These samples were submitted to Soil Engineering Testing (SET) in Bloomington, Minnesota, for sieve and hydrometer analyses. Data from the analyses were used to estimate hydraulic conductivity values for the soil (Barr, D.B., 2001). Laboratory reports of the grain size analyses are presented in Appendix C.

Thin wall tube samples were collected from the native clay material at the base of the CCR impoundment and submitted to SET to analyze hydraulic conductivity (also known as the coefficient of permeability) of the soil. Results of the lab tests were presented in the *Boswell Energy Center CCR Surface Impoundments Liner Evaluation* (Barr, 2016a).

4.0 Site Geology and Hydrostratigraphic Units

Information from multiple sources was used to develop geologic cross-sections of the site. Locations of cross-sections included in this report are presented on Figure 3. Cross-sections are presented as Figures 4a-4j. These geologic cross-sections were used to develop an understanding of the geologic and hydrostratigraphic units in the vicinity of the CCR impoundment. The sources of geologic information included:

- Boring logs for soil borings and monitoring wells installed in the vicinity of the CCR impoundments;
- Boring logs for soil borings installed prior to construction of the CCR impoundment (Ebasco, 1977a; 1977b); and
- Information on CCR impoundment construction (Ebasco, 1977a; 1977b) indicating that native clay from some areas within the footprint of the impoundments was moved to fill other areas within the footprint at the time of CCR impoundment construction. A slurry wall was also installed in portions of the CCR impoundment to help form a continuous liner. The full details of clay movement and slurry wall construction are not included on the cross-sections, as the vertical scale of the cross-sections is to present the underlying geologic information.

The following sections provide a summary of the site geology interpreted from the cross-sections. Geologic units observed in the vicinity of the CCR impoundment are grouped into hydrostratigraphic units to develop a site conceptual model that describes groundwater flow at the site.

4.1 General Description and Categories of Unconsolidated Deposits Observed in Borings

Unconsolidated deposits observed at the site can be categorized into two general categories that are consistent with descriptions in the USGS regional groundwater model (Jones, 2004) — 1) fine-grained glacial till, and 2) coarse-grained outwash deposits. The glacial till and outwash deposits are present around the CCR impoundment in a complex interlayered sequence that varies both laterally and vertically. Individual layers of till or outwash deposits vary in composition both laterally and vertically, and few layers can be correlated across the entire investigation area. General descriptions of the materials are provided below, followed by a description of the stratigraphy of the deposits.

4.1.1 Glacial Till Deposits

Relatively thick sequences of clayey and silty glacial till are present in many areas across the site. The thickness of the various till deposits ranges from approximately 5 feet to greater than 150 feet and is commonly 20 to 40 feet. The till is mainly composed of clay with varying amounts of silt, sand, and gravel. Some lenses are present within the till sequence that are dominantly sandy or silty. These lenses were generally encountered in single borings or a limited number of adjacent borings, indicating their discontinuous nature. Because these lenses are not continuous laterally or vertically and are surrounded by till composed mostly of clay, they are considered to be part of the till deposits for purposes of this site conceptual model.

4.1.2 Outwash Deposits

Outwash and fluvial deposits of dominantly sandy material are also present at the site. The thickness of the outwash deposits range from approximately 5 feet to greater than 100 feet and is commonly 15 to 40 feet. The outwash deposits are dominantly composed of sandy material with variable amounts of clay, silt, and gravel. The amount of fine-grained material in the outwash deposits is variable laterally and vertically within each deposit of outwash. The amount of silt and/or clay varies from less than 5 percent to 45 percent in localized areas. Thin lenses of dominantly silty or clayey material are also present in the outwash, though these lenses are not laterally or vertically continuous. Lenses of fine-grained material within outwash deposits were generally encountered in one boring or a limited number of adjacent borings. Therefore, these localized fine-grained deposits are considered part of the outwash deposits for purposes of this site conceptual model.

4.2 Distribution of Glacial Till and Outwash Deposits

The outwash and till deposits are generally not present in layers that are continuous across the entire site area. Most layers are discontinuous both laterally and vertically. This section provides a description of the lateral and vertical distribution of the deposits encountered at the site.

4.2.1 Surficial Glacial Till Deposit

A surficial clayey glacial till deposit is present across most of the area beneath and around the CCR impoundment, serving as the primary liner and liner material source for the CCR impoundment. The surficial till is absent in an area west and southwest of the CCR Landfill and Unit 3 Surface Impoundment (Figure 5). The thickness of the surficial till deposit ranges from approximately 5 feet to greater than 100 feet and is commonly 15 to 30 feet. This glacial till deposit serves as the natural clay liner below the CCR impoundment, except in the extreme southwest corner where an engineered clay liner was constructed (Figures 4c, 4d).

The surficial till deposit is also present south of the CCR impoundment, but is overlain by a thin layer of sand and peat deposits in the southeast area of the CCR impoundment (In the Bottom Ash Surface Impoundment, Figure 5) and to the south of the CCR impoundment in the area of the Old Bottom Ash Pond impoundment.

4.2.2 Surficial Outwash and Peat Deposits in Southeast Area of CCR Impoundment

A surficial layer of outwash sand was encountered in soil borings advanced in the southeast portion of the CCR impoundment prior to the construction of the CCR impoundment. The location of the surficial sand deposit is shown on Figure 5. The thickness of the sand over the surficial till deposit in the southeast area of the Bottom Ash Surface Impoundment ranged from approximately 2 to 10 feet. Peat was also observed in a few borings in the southeast corner of the Bottom Ash Surface Impoundment. These surficial sand and peat deposits were removed from portions of the CCR impoundment footprint during construction activities. Information regarding CCR impoundment construction activities was presented in *CCR Surface Impoundments History of Construction* (Barr, 2016b).

A USGS topographic map showing the surface topography prior to construction of the CCR impoundment is presented as Figure 6. Wetland areas shown on that map indicate areas where peat may have been present. The map also shows a topographically low area extending from the southeast corner of the CCR impoundment toward Blackwater Lake. The surficial sand observed in the area of this topographic low was up to 20 feet thick; however, silt, clay and peat were also observed in borings advanced in the general area of the topographic low, and the surficial till was present below the sand. This topographic low appears to be a gully eroded into the surficial till, then subsequently partially filled with sand, clay, and peat deposits (Figure 4d). The northern extent of the filled topographic low is under the CCR impoundment and does not extend beyond the impoundment area to the west, east or north (Figure 6).

The surficial sand layer and peat deposits become thicker south of the CCR impoundment and toward Blackwater Lake. The surficial layer also contains interbedded silt and clay layers up to 10 feet thick as the thickness of this surficial layer increases. This surficial layer, including peat, is approximately 20 to 40 feet thick near Blackwater Lake. The top of the surficial till deposit also slopes down toward Blackwater Lake; the elevation of the top of the till surface is approximately 1285 to 1295 feet MSL along the southern edge of the CCR impoundment and slopes down to approximately 1250 to 1260 feet MSL at the lowest point between the CCR impoundment and Blackwater Lake. The surficial sand and peat deposits appear to be the youngest deposits in the area.

4.2.3 Surficial Outwash Deposit on West Side of CCR Impoundment

Outwash deposits are present at the surface where the surficial till deposit is absent west and southwest of the CCR impoundment (Figure 5). The thickness of this outwash deposit ranges from approximately 30 to over 100 feet. Few borings were drilled to sufficient depths to define the base of this deposit. The top of a lower till unit below this surficial outwash deposit was encountered at elevations ranging from a high of elevation 1250 to 1265 feet MSL in the northwest corner of the CCR impoundment, at BW-2S in the northwest corner of the investigation area, and at BW-1S/BW-1D to the west of the CCR impoundment. However, the elevation of the bottom of this outwash deposit may drop below elevations of 1200 feet MSL at well BW-3D in the northern portion of the investigation area (Figure 4f), and below 1230 feet MSL south of the CCR impoundment toward Blackwater Lake.

This outwash deposit extends laterally beyond the area where it is present at the surface as shown on Figure 3. This outwash deposit extends to the north under the surficial till deposit (Section 4.2.1) to BW-2S and BW-3D, both of which encountered this deposit. The deposit also extends an unknown distance to the west outside the investigation area and to the south to at least the Mississippi River and Blackwater Lake.

This surficial outwash deposit does extend to the east under the western portion of the CCR impoundment and under the Old Bottom Ash Pond impoundment (Figures 4a, 4b, 4c, 4d, 4e, and 4f). However, the surficial till deposit overlies the surficial outwash deposit in these areas (Figure 5).

The upper portion of this surficial outwash deposit within the elevation range of the monitoring wells (approximately 1240 to 1310 ft MSL) appears to be pinched out to the east under the CCR impoundment (Figures 4b, 4c, 4d, 4e, and 4f). There is a thick layer of till material that extends to depths below the termination depths of soil borings present with an irregular outline that extends across the middle of the CCR impoundment with a north-south orientation (Figure 7). The base of this deep extent of till is unknown and extends to elevations below approximately 1229 feet at boring NA-183D, 1212 feet at boring NA193D, 1175 feet at boring NA1D, 1200 feet at boring DB-2, and 1165 feet at boring DB-4. The base of the deep extent of till may be at an elevation of approximately 1175 feet at boring DB-3 at the eastern edge of the Old Bottom Ash Pond.

4.2.4 Buried Outwash Deposit on East Side of CCR Impoundment

An outwash deposit is also present on the east side of the CCR impoundment and east of the area with the deep extent of till that is shown on Figure 7. This outwash deposit is overlain by the surficial clay described in Section 4.2.1. The top of this unit is defined by the base of the overlying till and is present at an elevation of approximately 1250 to 1270 feet MSL. The bottom of this outwash deposit was not encountered in any boring but occurs below approximately 1230 to 1210 feet MSL. This deposit was encountered in all borings drilled to sufficient depths along the eastern portion of the CCR impoundment and east of the deep extent of till (Figures 4a, 4b, 4c, 4e, 4g, and 4j). The western lateral extent of this outwash deposit within the elevation range of the monitoring well screens is the deep extent of till. The lateral extent of this outwash deposit is unknown to the east or north and appears to extend south to at least Blackwater Lake.

4.2.5 Deeper Till Layer

The deeper glacial till layer defines the base of the surficial outwash deposit described in Section 4.2.3. The top of this till unit is an uneven surface below the overlying surficial outwash at elevations ranging from 1265 feet to approximately 1200 feet MSL (Figures 4b, 4c, and 4d). This deep till layer is anticipated to be present to the east of the CCR impoundment as a unit below the buried outwash aquifer based on information presented by the USGS (Jones, 2004). The top of the till layer to the east of the CCR impoundment is below elevations of approximately 1230 to 1210 feet MSL based on the deepest borings advanced in this area.

The lower surface of this deep till was encountered in one boring (BW-1D) at an elevation of approximately 1220 feet MSL. The thickness of the till was approximately 50 feet at BW-1D.

4.2.6 Deep Outwash Deposit

An outwash deposit was encountered below the deeper till layer (Section 4.2.5) in one boring advanced at the site (BW-1D). The elevation of the top of this deep outwash deposit was approximately 1220 feet MSL at this location. The extent of this deposit is unknown but may correlate with the middle outwash aquifer of the USGS groundwater model for the region (Jones, 2004). Three water supply wells are present at BEC east of the CCR impoundment area and across Blackwater Lake/Blackwater Creek. The water supply wells appear to be screened within the deep outwash deposit.

4.3 Hydrostratigraphic Units

Sections 4.2.1 through 4.2.6 provide a description of the glacial till and outwash deposits interpreted to be present in the area of the CCR impoundment. This section presents the deposits described in Sections 4.2.1 through 4.2.6 as hydrostratigraphic units. Hydrostratigraphic units are defined as geologic deposits with "considerable lateral extent that compose a geologic framework for a reasonably distinct hydrologic system" (Maxey, 1964). The definition includes consideration of the dynamics of the hydrological regime (hydrologic conditions). Consistent with this approach, geologic deposits with limited lateral extent and thickness are grouped into the primary hydrostratigraphic units that surround them (e.g., a silt lens in the outwash aquifer or a sand lens in the till are lumped into the primary hydrostratigraphic unit).

The hydrostratigraphic units defined for BEC include deposits that are considered aquifers and deposits that are not considered aquifers. According to 40 CFR §257.53 (US EPA, 2015), an aquifer is defined as a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs. Formations composed of clay are not capable of producing significant quantities of water and retard movement of groundwater. Therefore, the glacial till units, which are predominantly composed of clay, are not considered aquifers.

The potential aquifer formations at BEC based on the geologic descriptions include:

- the surficial outwash deposit on the southeast side of the CCR impoundment (Section 4.3.1);
- the surficial outwash deposit on the west side of the CCR impoundment (Section 4.3.2);
- the buried outwash deposit on the east side of the CCR impoundment (Section 4.3.2); and
- the deep outwash deposit (Section 4.3.3).

4.3.1 Surficial Outwash on Southeast Side of CCR Impoundment

The surficial outwash deposit on the southeast side of the CCR impoundment (Section 4.2.2) does not appear to be saturated in the vicinity of the CCR impoundment based on data from shallow well A178. Therefore, this unit is not considered an aquifer near the CCR impoundment, except possibly in the area where a filled topographic low is present as described in Section 4.2.2 and shown on Figure 6. Wells A178D and NA186S are installed within this area (Figure 4d). This aquifer is not laterally extensive and is limited to the deeper portion of the filled low where sand is present. The bottom and sides of the filled low are part of the surficial glacial till. This deposit is present beyond the boundaries of the CCR impoundment only in the southeast portion of the impoundment (Figure 6).

4.3.2 Surficial and Buried Outwash Deposits on West and East Side of CCR Impoundment

Outwash deposits are present along the west and east portions of the CCR impoundment (Sections 4.2.3 and 4.2.4). However, these deposits are not present within the elevation range where monitoring wells are screened in the middle portion of the CCR impoundment where the surficial glacial till extends to depths below the elevations of all monitoring well screens. No aquifer unit was encountered within 80 to 130 feet of ground surface where the deep extent of till is present. This includes the area across the middle of the CCR impoundment, an area approximately 700-feet wide on the north side of the CCR impoundment, an area approximately 2800-feet wide along the middle of the south side of the CCR impoundment, and an area approximately 1,000-feet wide along the west side of the CCR impoundment (Figure 7).

The outwash deposits on either side of the deep extent of till are at similar elevations and appear to have similar thickness. The outwash deposits in the elevation range of the monitoring well network, appear to be separated into eastern and western areas under the CCR impoundment by the deep extent of glacial till. The area where the deep extent of till was observed decreases in width on the north edge of the CCR impoundment, and the northern extent of the deep till is unknown. The bottom of the deep extent of till was encountered in boring DB-1 at an elevation of approximately 1250 feet MSL (Figure 4a). Therefore, the base of the deep till appears to be sloping upward in this area, although the base in this area is below the elevations of the monitoring well screens to the east and west of this location. The east and west outwash deposit areas appear to be connected and part of the same outwash deposit to the north or south of the CCR impoundment, or below the base of the deep extent of till. The outwash deposit in the Old Bottom Ash Pond impoundment area appears to be associated with the western surficial outwash deposit as this area appears to be on the west side of the deep extent of till (Figure 5).

4.3.3 Deep Outwash Deposit

The deep outwash deposit was only encountered at well BW-1D in the investigation area. This aquifer is present below the glacial till that defines the bottom of the surficial/buried outwash deposits encountered on the east and west sides of the CCR impoundment. This aquifer may be present below the CCR impoundment but was not encountered in borings advanced to depths of 130 feet. Three water supply wells at BEC also appear to obtain water from the deep outwash deposit.

5.0 Site Hydrogeology and Conceptual Model

5.1 Monitoring Well Information

A total of 52 monitoring wells are present at BEC. These wells have been installed for various reasons over a multi-year period and have been constructed with screens placed in the various geologic deposits in the area. A groundwater monitoring system that meets and exceeds the minimum requirements of Section 257.91 has been designed for the CCR impoundment, including the following monitoring wells:

■ Upgradient: BW-1S, BW-2S, BW-3D

■ Downgradient: A174D, A178D, A180D, NA181D, NA184D, NA186S, NA186D, NA187D, A188D, A189D, A190D, A191D, A192D, A194S

The October 2017 Groundwater Monitoring System Certification is accessible on Minnesota Power's CCR website for BEC. Locations of wells in the CCR groundwater monitoring system are shown on Figures 7 through 11.

5.2 Groundwater Flow Directions and Velocities

Groundwater flow directions and gradients at BEC are determined by water level elevations (head) measured in the wells. Flow pathways, directions, and gradients are different between the hydrostratigraphic units. Only wells constructed in the same hydrostratigraphic unit were used to evaluate flow directions and gradients within the unit. In general, groundwater flow direction in units with low hydraulic conductivity (K) that overly units with higher K is vertical towards units with higher K values (Freeze and Cherry, 1979). Groundwater flow directions in higher K units are dominantly lateral toward discharge areas. Hydraulic conductivity values for the soil at the well screen intervals are shown on Table 1 and are used to estimate groundwater flow velocities (Section 5.2.1).

5.2.1 Lateral Groundwater Flow

Lateral groundwater flow is expected to occur within the three outwash deposits. Groundwater contour maps showing groundwater elevations in the surficial and buried outwash aquifers are presented in Figures 8 through 11, using measurements from July 2016 used to establish the CCR impoundment groundwater monitoring network (Figure 7), and several subsequent sets of water level measurements.

The groundwater flow direction is:

- west to east in the area northwest of the CCR impoundment,
- southwest to south in the area on the east side of the CCR impoundment, and
- south to southwest on the southwest side of the CCR impoundment.

Flow is toward the Mississippi River and Blackwater Lake on the southwest and east sides of the CCR impoundment. The deep extent of till below the center of the CCR impoundment appears to deflect flow on the west side of the CCR impoundment. Northwest of the deep extent of till, groundwater appears to flow toward the northwest corner of the CCR impoundment then along the till away from the CCR impoundment to the northeast. The deep extent of till may be missing to the north of the CCR impoundment as groundwater elevations at BW-3D, A192D, NA187D, and NA181D indicate that groundwater flow may wrap around the deep extent of till in the area north of the CCR impoundment and flow along the east side of the CCR impoundment to the south/southeast. Groundwater flow in the southwest corner of the CCR impoundment flows away from the CCR impoundment. Higher groundwater elevations are observed at wells along the southwest edge of the CCR impoundment where the surficial till is absent, and there appears to be a mound in the groundwater table in this area with flow away from the CCR impoundment. The higher groundwater elevations on the west side of the impoundment compared with the east side may be related to the deep extent of till acting as a localized impediment to flow, which results in a buildup of head or "damming" of flow in this area.

The lateral groundwater velocity ranges from approximately 0.001 foot per day to 2 feet per day based on K values available from grain-size analyses and slug tests (Table 2), and from gradients determined from the groundwater contour map. The lateral hydraulic gradients in the outwash aquifer ranges from approximately 0.002 to 0.008 foot per foot (ft/ft).

Groundwater contour maps are not included for the deeper outwash because only one well (BW-1D) is present in that unit. Flow directions are expected to be similar to the general flow direction in the surficial and buried outwash where the flow direction is in the down-valley direction along the Mississippi River. The flow direction will locally be directed toward the Mississippi River and associated lakes in the vicinity of the surface water features.

Groundwater contour maps are also not presented for the surficial outwash on the southeast side of the CCR impoundments. Two wells are constructed with screens in a sandy deposit that overlies the surficial clay south of the southeast area of the CCR impoundment (A178D and NA186S) and both appear to be screened within a sand layer associated with deposits within the topographic low area in the surficial till (Section 4.3.1). The wells are adjacent to each other and two wells are not sufficient to generate a contour map. Flow direction is expected to be toward Blackwater Lake parallel to the orientation of the partially filled topographic low.

5.2.2 Vertical Groundwater Flow

Groundwater flow in the surficial till is expected to be downward toward the underlying outwash aquifer. Nested wells are present in areas around the CCR impoundment where the shallow well in the nest is screened in the surficial till, and the deeper well is screened in the underlying outwash. The vertical hydraulic gradient between water levels measured in till and water levels measured in the underlying outwash indicate the vertical gradient is downward from overlying clay to underlying sand at a gradient of approximately 0.3 to 0.7 ft/ft (Table 4). Downward groundwater velocities through the till are approximately 0.004 foot to 0.000004 foot per day based on the gradient and K values of approximately 0.002 to 0.000005 foot per day obtained from laboratory testing.

To evaluate flow between aquifer units, the vertical gradient was calculated for well nest at BW-1S, where the shallow well is screened in the surficial outwash and the deeper well appears to be screened in the deeper outwash deposit. A downward gradient is present between the wells (Table 4) of approximately 0.01 to 0.02 ft/ft.

The vertical gradient was also calculated for well nest NA186S and NA186D, where the shallow well appears to be screened in a deposit above the surficial till (Section 4.3.1), and the deep well appears to be screened in the buried outwash deposit below the surficial till (Section 4.3.2). The gradient is variable and ranges from approximately 0.05 ft/ft in the downward direction to 0.01 ft/ft in the upward direction.

5.3 Uppermost Aquifer

According to 40 CFR §257.53 (US EPA, 2015), the uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary.

The uppermost aquifer in the area of the CCR impoundment consists of the surficial outwash deposit on northwest, west, south to southwest sides; the buried outwash deposit on the northeast, east, and southeast sides (Section 4.3.2); and the channel fill sandy deposits within the filled topographic low overlying the surficial till deposit in the southeast portion of the CCR impoundment in the Bottom Ash Surface Impoundment Area (Figure 6) (Section 4.3.1). The buried outwash deposit is present at depth below the surficial clay in the area of the channel fill and is hydraulically downgradient from areas where the buried outwash aquifer is the uppermost aquifer in the areas east of the CCR impoundment. Figure 7 presents a map view of the hydrostratigraphic unit that forms the uppermost aquifer in each area around the CCR impoundment.

Deep till deposits are present along a portion of the west side of the CCR impoundment and along the center of the CCR impoundment (Figures 7 through 11). The uppermost aquifer may be deep outwash at this location; however, no aquifer was encountered in borings greater than 100 feet deep in these areas.

6.0 Summary and Conclusions

The geology at BEC consists of a complex sequence of glacial deposits but can be grouped into a few outwash and till hydrostratigraphic units to identify primary pathways for groundwater flow from the CCR impoundment to the uppermost aquifer. Native till is the uppermost hydrostratigraphic unit beneath the CCR impoundment, except at the southwest corner of the Unit 3 Surface Impoundment, where an engineered liner was constructed using till material from other portions of the site. On the western side of the Unit 3 and Unit 4 Surface Impoundments, the uppermost aquifer is the surficial outwash that is below surficial till or the engineered liner within the footprint of the CCR impoundment. In the central part of the CCR impoundment, a thick layer of till is present from the base of the impoundment to depths that are locally greater than 130 feet. On the eastern side of the Unit 4 and Bottom Ash Surface Impoundments, the uppermost aquifer is the buried outwash which underlies approximately 20 to 50 feet of surficial till. A sediment filled topographic low on the surface of the surficial till is present beneath the Bottom Ash Surface Impoundment in the southeast corner of the CCR Impoundment. This filled low area is limited in extent, although it does contain saturated sand below the CCR impoundment that extends to the south toward Blackwater Lake. The buried outwash aquifer is present below the surficial till in the area of the filled topographic low.

7.0 References

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Tables

Table 1
Hydraulic Conductivity Values

Location	Hydraulic Conductivity Estimate (ft/d)	Reported Material	Test/Analysis
Horizontal Hydraulic Conductivity			
A1S	3.90E-02	Clay	Slug Test
A-1W	2.83E-05	Clay	Field Permeability Test
A-2W	2.83E-05	Clay	Field Permeability Test
A-9W	2.61E-03	Clay	Field Permeability Test
A-109	1.59E-04	Clay	Field Permeability Test
A-117	2.83E-05	Clay	Field Permeability Test
A183D	2.55E-01	Clay	Slug Test
NA187S	3.80E-03	Clay	Slug Test
APK-1	1.75E-01	Clay	Grain Size
APK-2	3.82E-02	Clay	Grain Size
APK-3	2.73E-02	Clay	Grain Size
APK-4	8.52E-02	Clay	Grain Size
APK-4	3.23E-02	Clay	Grain Size
APK-5	3.87E-02	Clay	Grain Size
APK-6	4.61E-02	Clay	Grain Size
APK-7	2.88E-02	Clay	Grain Size
APK-8	3.00E-02	Clay	Grain Size
APK-9	2.81E-02	Clay	Grain Size
APK-10	3.20E-02	Clay	Grain Size
APK-11	2.47E-02	Clay	Grain Size
APK-12	4.05E-02	Clay	Grain Size
APK-12	2.66E-02	Clay	Grain Size
C-AP5	3.09E-02	Clay	Grain Size
C-A28	3.67E-02	Clay	Grain Size
C-A71	3.90E-02	Clay	Grain Size
A180S	1.56E-02	Clay / Silt with Sand	Slug Test
A174S	3.69E-01	Silty Sand / Clay	Slug Test
A1D	2.29E-01	Silt with Sand	Slug Test
BW-1D	1.99E+01	Silty Sand	Grain Size
BW-1D	1.99E+01	Silty Sand	Grain Size
BW-1D	4.48E+01	Silty Sand	Grain Size
A9D	7.40E-01	Sand	Slug Test
A174D	5.85E-02	Sand	Slug Test
A180D	1.65E+00	Sand	Slug Test
A183S	9.90E-02	Sand	Slug Test
NA187D	5.70E-02	Sand	Slug Test
BW-1	8.73E+01	Sand	Grain Size
Vertical Hydraulic Conductivity			
A-19	1.01E-03	Clay	Lab Permeability
A-85	2.11E-05	Clay	Lab Permeability
A-90	6.90E-04	Clay	Lab Permeability
A-106	1.87E-02	Clay	Lab Permeability
APK-1	8.50E-04	Clay	Lab Permeability
APK-2	9.07E-05	Clay	Lab Permeability
APK-3	6.19E-05	Clay	Lab Permeability
APK-4	2.02E-03	Clay	Lab Permeability
APK-4	1.08E-04	Clay	Lab Permeability
APK-5	5.04E-06	Clay	Lab Permeability
APK-6	1.25E-05	Clay	Lab Permeability
APK-7	1.58E-05	Clay	Lab Permeability
APK-8	1.05E-05	Clay	Lab Permeability
APK-9	1.44E-05	Clay	Lab Permeability
APK-10	1.10E-05	Clay	Lab Permeability
APK-11	1.73E-05	Clay	Lab Permeability
APK-12	2.88E-05	Clay	Lab Permeability
APK-12	1.11E-05	Clay	Lab Permeability

Table 1
Hydraulic Conductivity Values

Location	Hydraulic Conductivity Estimate (ft/d)	Reported Material	Test/Analysis
C-AP5	2.59E-05	Clay	Lab Permeability
C-A28	2.45E-05	Clay	Lab Permeability
C-A71	2.45E-05	Clay	Lab Permeability
APK-1	1.40E-02	Silty Clayey Sand	Lab Permeability
APK-1	3.17E-01	Silty Sand	Lab Permeability
APK-4	1.02E-01	Silty Sand	Lab Permeability

Table 2
Water Elevation Data in Monitoring Wells

Location	Date	TOC Elevation (feet NGVD)	Depth to Groundwater (feet)	Groundwater Elevation (feet NGVD)
A174D	4/1/15	1325.77	49.70	1276.07
A174D	7/1/15	1325.77	48.96	1276.81
A174D	10/1/15	1325.77	48.98	1276.79
A174D	2/25/16	1325.77	50.18	1275.59
A174D	4/1/16	1325.77	48.47	1277.30
A174D	7/1/16	1325.77	48.36	1277.41
A174D	7/28/16	1325.77	48.68	1277.09
A174D	9/26/16	1325.77	48.61	1277.16
A174D	10/1/16	1325.77	49.10	1276.67
A174D	11/7/16	1325.77	49.06	1276.71
A174D	12/5/16	1325.77	48.87	1276.90
A174D	2/13/17	1325.77	50.02	1275.75
A174D	4/1/17	1325.77	48.49	1277.28
A174D	4/24/17	1325.77	48.49	1277.28
A174D	6/5/17	1325.77	48.58	1277.19
A174D	7/27/17	1325.77	48.65	1277.12
A174S	4/1/15	1323.94	41.95	1281.99
A174S	7/1/15	1323.94	42.09	1281.85
A174S	10/1/15	1323.94	42.44	1281.50
A174S	2/25/16	1323.94	42.24	1281.70
A174S	4/1/16	1323.94	42.98	1280.96
A174S	7/1/16	1323.94	41.23	1282.71
A174S	10/1/16	1323.94	42.55	1281.39
A174S	4/1/17	1323.94	39.79	1284.15
A174S	7/27/17	1323.94	40.00	1283.94
A177S	7/1/15	1294.97	5.99	1288.98
A177S	2/25/16	1294.97	6.30	1288.67
A177S	7/1/16	1294.97	4.94	1290.03
A177S	7/27/17	1294.97	5.80	1289.17
A178D	7/1/15	1293.67	17.80	1275.87
A178D	2/25/16	1293.67	19.21	1274.46
A178D	2/26/16	1293.67	19.21	1274.46
A178D	7/1/16	1293.67	17.24	1276.43
A178D	7/28/16	1293.67	17.58	1276.09
A178D	9/26/16	1293.67	17.53	1276.14
A178D	11/7/16	1293.67	18.06	1275.61
A178D	12/5/16	1293.67	17.85	1275.82
A178D	2/13/17	1293.67	19.11	1274.56
A178D	4/24/17	1293.67	17.38	1276.29
A178D	6/5/17	1293.67	17.53	1276.14
A178D	7/27/17	1293.67	17.08	1276.59
A178S	2/26/16	1294.29	DRY	
A180D	7/1/15	1324.61	47.03	1277.58
A180D	2/25/16	1324.61	48.15	1276.46
A180D	7/1/16	1324.61	46.44	1278.17
A180D	7/28/16	1324.61	46.78	1277.83

Table 2
Water Elevation Data in Monitoring Wells

Location	Date	TOC Elevation (feet NGVD)	Depth to Groundwater (feet)	Groundwater Elevation (feet NGVD)
A180D	9/26/16	1324.61	46.66	1277.95
A180D	11/7/16	1324.61	47.08	1277.53
A180D	12/5/16	1324.61	46.92	1277.69
A180D	2/13/17	1324.61	47.95	1276.66
A180D	4/24/17	1324.61	46.56	1278.05
A180D	6/5/17	1324.61	46.62	1277.99
A180D	7/27/17	1324.61	46.72	1277.89
A180S	7/1/15	1324.30	36.84	1287.46
A180S	2/25/16	1324.30	37.08	1287.22
A180S	7/1/16	1324.30	35.85	1288.45
A180S	7/27/17	1324.30	36.15	1288.15
A181D	7/1/15	1298.61	20.35	1278.26
A181D	2/25/16	1298.61	21.50	1277.11
A181D	7/1/16	1298.61	19.84	1278.77
A181D	7/27/17	1298.61	20.07	1278.54
A181S	2/25/16	1299.80	10.72	1289.08
A182D	7/1/15	1304.35	12.51	1291.84
A182D	2/25/16	1304.35	11.99	1292.36
A182D	7/1/16	1304.35	17.39	1286.96
A182D	7/27/17	1304.35	13.69	1290.66
A182S	7/1/15	1304.36	5.62	1298.74
A182S	2/25/16	1304.36	6.61	1297.75
A182S	7/1/16	1304.36	4.85	1299.51
A182S	7/27/17	1304.36	8.23	1296.13
A183D	7/1/15	1324.80	32.22	1292.58
A183D	2/25/16	1324.80	33.41	1291.39
A183D	7/1/16	1324.80	29.97	1294.83
A183D	7/27/17	1324.80	29.80	1295.00
A183S	7/1/15	1325.23	26.65	1298.58
A183S	2/25/16	1325.23	26.47	1298.76
A183S	7/1/16	1325.23	22.85	1302.38
A183S	7/27/17	1325.23	20.40	1304.83
A184D	2/25/15	1309.63	14.75	1294.88
A184D	4/1/15	1309.63	14.45	1295.18
A184D	7/1/15	1309.63	13.35	1296.28
A184D	10/1/15	1309.63	13.69	1295.94
A184D	2/25/16	1309.63	14.75	1294.88
A184D	4/1/16	1309.63	13.50	1296.13
A184D	7/1/16	1309.63	12.82	1296.81
A184D	10/1/16	1309.63	12.85	1296.78
A184D	4/1/17	1309.63	12.62	1297.01
A184D	7/27/17	1309.63	11.90	1297.73
A185D	7/1/15	1325.09	43.44	1281.65
A185D	2/25/16	1325.09	44.58	1280.51

Table 2
Water Elevation Data in Monitoring Wells

Location	Date	TOC Elevation (feet NGVD)	Depth to Groundwater (feet)	Groundwater Elevation (feet NGVD)
A185D	7/1/16	1325.09	42.85	1282.24
A185D	7/27/17	1325.09	43.09	1282.00
A185S	7/1/15	1325.62	14.07	1311.55
A185S	2/25/16	1325.62	13.86	1311.76
A185S	7/1/16	1325.62	12.53	1313.09
A185S	7/27/17	1325.62	12.30	1313.32
A188D	7/28/16	1297.50	20.85	1276.65
A188D	9/26/16	1297.50	19.82	1277.68
A188D	11/7/16	1297.50	21.28	1276.22
A188D	12/5/16	1297.50	21.11	1276.39
A188D	2/13/17	1297.50	22.30	1275.20
A188D	4/24/17	1297.50	20.67	1276.83
A188D	6/5/17	1297.50	20.79	1276.71
A189D	7/28/16	1299.94	23.87	1276.07
A189D	9/26/16	1299.94	23.83	1276.11
A189D	11/7/16	1299.94	24.21	1275.73
A189D	12/5/16	1299.94	24.08	1275.86
A189D	2/13/17	1299.94	25.35	1274.59
A189D	4/24/17	1299.94	23.71	1276.23
A189D	6/5/17	1299.94	23.75	1276.19
A190D	7/28/16	1308.67	13.80	1294.87
A190D	9/26/16	1308.67	13.32	1295.35
A190D	11/7/16	1308.67	13.96	1294.71
A190D	12/5/16	1308.67	14.72	1293.95
A190D	2/13/17	1308.67	14.53	1294.14
A190D	4/24/17	1308.67	13.35	1295.32
A190D	6/5/17	1308.67	13.72	1294.95
A191D	7/28/16	1311.49	11.14	1300.35
A191D	9/26/16	1311.49	10.51	1300.98
A191D	11/7/16	1311.49	11.18	1300.31
A191D	12/5/16	1311.49	10.62	1300.87
A191D	2/13/17	1311.49	11.50	1299.99
A191D	4/24/17	1311.49	9.57	1301.92
A191D	6/5/17	1311.49	10.08	1301.41
A192D	7/28/16	1304.72	24.26	1280.46
A192D	9/26/16	1304.72	24.17	1280.55
A192D	11/7/16	1304.72	24.60	1280.12
A192D	12/5/16	1304.72	24.38	1280.34
A192D	2/13/17	1304.72	25.23	1279.49
A192D	4/24/17	1304.72	23.93	1280.79
A192D	6/5/17	1304.72	23.97	1280.75
A194S	7/28/16	1315.77	16.78	1298.99
A194S	9/26/16	1315.77	16.30	1299.47
A194S	11/7/16	1315.77	16.88	1298.89
A194S	12/5/16	1315.77	16.97	1298.80

Table 2
Water Elevation Data in Monitoring Wells

Location	Date	TOC Elevation (feet NGVD)	Depth to Groundwater (feet)	Groundwater Elevation (feet NGVD)
A194S	2/13/17	1315.77	17.53	1298.24
A194S	4/24/17	1315.77	16.72	1299.05
A194S	6/4/17	1315.77	16.47	1299.30
A1D	7/1/15	1300.66	14.97	1285.69
A1D	2/25/16	1300.66	15.86	1284.80
A1D	2/26/16	1300.66	15.86	1284.80
A1D	7/1/16	1300.66	14.51	1286.15
A1D	7/27/17	1300.66	14.55	1286.11
A1S	7/1/15	1301.91	8.66	1293.25
A1S	2/25/16	1301.91	7.90	1294.01
A1S	2/26/16	1299.40	7.90	1291.50
A1S	7/1/16	1301.91	5.83	1296.08
A1S	7/27/17	1301.91	4.98	1296.93
A9D	7/1/15	1305.09	15.62	1289.47
A9D	2/25/16	1304.65	16.76	1287.89
A9D	2/26/16	1304.30	16.76	1287.54
A9D	7/1/16	1305.09	14.74	1290.35
A9D	7/27/17	1305.09	14.75	1290.34
A9S	7/1/15	1304.74	DRY	
A9S	2/26/16	1304.50	DRY	
A9S	7/1/16	1304.74	DRY	
A9S	7/27/17	1304.74	DRY	
BW-1D	5/25/16	1321.97	30.11	1291.86
BW-1D	7/28/16	1321.97	30.03	1291.94
BW-1D	9/26/16	1321.97	29.67	1292.30
BW-1D	11/7/16	1321.97	29.62	1292.35
BW-1D	12/5/16	1321.97	29.57	1292.40
BW-1D	2/13/17	1321.97	28.32	1293.65
BW-1D	4/24/17	1321.97	29.03	1292.94
BW-1D	6/5/17	1321.97	28.89	1293.08
BW-1S	2/25/16	1322.34	28.96	1293.38
BW-1S	5/25/16	1322.34	28.46	1293.88
BW-1S	7/28/16	1322.34	28.31	1294.03
BW-1S	9/26/16	1322.34	27.95	1294.39
BW-1S	11/7/16	1322.34	27.92	1294.42
BW-1S	12/5/16	1322.34	27.81	1294.53
BW-1S	2/13/17	1322.34	27.68	1294.66
BW-1S	4/24/17	1322.34	27.32	1295.02
BW-1S	6/5/17	1322.34	17.05	1305.29
BW-2	2/25/16	1310.68	8.94	1301.74
BW-2	5/24/16	1310.68	8.14	1302.54
BW-2	7/28/16	1310.68	8.16	1302.52
BW-2	9/26/16	1310.68	8.75	1301.93
BW-2	11/7/16	1310.68	9.14	1301.54
BW-2	12/5/16	1310.68	6.45	1304.23

Table 2
Water Elevation Data in Monitoring Wells

Location	Date	TOC Elevation (feet NGVD)	Depth to Groundwater (feet)	Groundwater Elevation (feet NGVD)
BW-2	2/13/17	1310.68	8.24	1302.44
BW-2	4/24/17	1310.68	4.95	1305.73
BW-2	6/4/17	1310.68	8.03	1302.65
BW-3	2/25/16	1301.15	22.53	1278.62
BW-3	5/25/16	1301.15	21.38	1279.77
BW-3	7/28/16	1301.15	21.35	1279.80
BW-3	9/26/16	1301.15	21.27	1279.88
BW-3	11/7/16	1301.15	21.63	1279.52
BW-3	12/5/16	1301.15	21.44	1279.71
BW-3	2/13/17	1301.15	22.25	1278.90
BW-3	4/24/17	1301.15	21.22	1279.93
BW-3	6/4/17	1301.15	21.15	1280.00
DM17	4/1/15	1297.66	DRY	
DM17	7/1/15	1297.66	DRY	
DM17	10/1/15	1297.66	DRY	
DM17	2/26/16	1297.66	DRY	
DM17	7/1/16	1297.66	8.33	1289.33
DM17	10/1/16	1297.66	DRY	
DM17	4/1/17	1297.66	5.65	1292.01
DM17	7/27/17	1297.66	DRY	
DM22C	4/1/15	1320.02	42.86	1277.16
DM22C	7/1/15	1320.02	42.28	1277.74
DM22C	10/1/15	1320.02	42.53	1277.49
DM22C	2/25/16	1320.02	42.87	1277.15
DM22C	2/26/16	1320.02	42.87	1277.15
DM22C	4/1/16	1320.02	41.35	1278.67
DM22C	7/1/16	1320.02	41.65	1278.37
DM22C	10/1/16	1320.02	42.30	1277.72
DM22C	4/1/17	1320.02	40.99	1279.03
DM22C	7/27/17	1320.02	42.30	1277.72
DM22D	4/1/15	1319.87	43.71	1276.16
DM22D	7/1/15	1319.87	42.29	1277.58
DM22D	10/1/15	1319.87	43.03	1276.84
DM22D	2/25/16	1319.87	44.28	1275.59
DM22D	2/26/16	1319.87	44.28	1275.59
DM22D	4/1/16	1319.87	42.60	1277.27
DM22D	7/1/16	1319.87	42.35	1277.52
DM22D	10/1/16	1319.87	43.02	1276.85
DM22D	4/1/17	1319.87	42.38	1277.49
DM22D	7/27/17	1319.87	42.87	1277.00
DM22S	4/1/15	1319.60	26.17	1293.43
DM22S	7/1/15	1319.60	24.39	1295.21
DM22S	10/1/15	1319.60	25.49	1294.11
DM22S	2/25/16	1319.60	25.79	1293.81
DM22S	2/26/16	1319.60	25.79	1293.81
DM22S	4/1/16	1319.60	6.84	1312.76

Table 2
Water Elevation Data in Monitoring Wells

Location	Date	TOC Elevation (feet NGVD)	Depth to Groundwater (feet)	Groundwater Elevation (feet NGVD)
DM22S	7/1/16	1319.60	24.12	1295.48
DM22S	10/1/16	1319.60	23.90	1295.70
DM22S	4/1/17	1319.60	23.05	1296.55
DM22S	7/27/17	1319.60	23.94	1295.66
HZ1D	4/1/15	1311.93	27.28	1284.65
HZ1D	7/1/15	1311.93	26.05	1285.88
HZ1D	10/1/15	1311.93	26.49	1285.44
HZ1D	2/25/16	1311.93	26.94	1284.99
HZ1D	4/1/16	1311.93	25.81	1286.12
HZ1D	7/1/16	1311.93	25.42	1286.51
HZ1D	10/1/16	1311.93	25.50	1286.43
HZ1D	4/1/17	1311.93	25.42	1286.51
HZ1D	7/27/17	1311.93	25.59	1286.34
HZ1S	2/25/16	1310.56	11.50	1299.06
NA177D	7/1/15	1293.68	18.22	1275.46
NA177D	7/1/16	1293.68	17.63	1276.05
NA177D	7/27/17	1293.68	19.49	1274.19
NA181D	2/25/16	1298.61	21.50	1277.11
NA181D	7/28/16	1298.61	20.12	1278.49
NA181D	9/26/16	1298.61	20.08	1278.53
NA181D	11/7/16	1298.61	20.47	1278.14
NA181D	12/5/16	1298.61	20.28	1278.33
NA181D	2/13/17	1298.61	21.32	1277.29
NA181D	4/24/17	1298.61	19.88	1278.73
NA181D	6/5/17	1298.61	20.03	1278.58
NA181S	7/1/15	1299.80	11.41	1288.39
NA181S	2/25/16	1299.80	10.72	1289.08
NA181S	7/1/16	1299.80	10.69	1289.11
NA181S	7/27/17	1299.80	12.00	1287.80
NA184D	7/28/16	1307.94	11.95	1295.99
NA184D	9/26/16	1307.94	11.47	1296.47
NA184D	11/7/16	1307.94	12.10	1295.84
NA184D	12/5/16	1307.94	11.82	1296.12
NA184D	2/13/17	1307.94	12.62	1295.32
NA184D	4/24/17	1307.94	11.52	1296.42
NA184D	6/5/17	1307.94	11.76	1296.18
NA186D	7/1/15	1282.82	5.59	1277.23
NA186D	2/25/16	1282.82	6.66	1276.16
NA186D	2/26/16	1282.82	6.66	1276.16
NA186D	7/1/16	1282.82	8.28	1274.54
NA186D	7/28/16	1282.82	5.30	1277.52
NA186D	9/26/16	1282.82	5.31	1277.51
NA186D	11/7/16	1282.82	5.78	1277.04
NA186D	12/5/16	1282.82	5.54	1277.28
NA186D	2/13/17	1282.82	6.83	1275.99

Table 2
Water Elevation Data in Monitoring Wells

Location	Date	TOC Elevation (feet NGVD)	Depth to Groundwater (feet)	Groundwater Elevation (feet NGVD)
NA186D	4/24/17	1282.82	5.05	1277.77
NA186D	6/5/17	1282.82	5.19	1277.63
NA186D	7/27/17	1282.82	7.36	1275.46
NA186S	7/1/15	1283.49	6.78	1276.71
NA186S	2/25/16	1283.49	5.76	1277.73
NA186S	2/26/16	1283.49	5.76	1277.73
NA186S	7/1/16	1283.49	6.45	1277.04
NA186S	7/28/16	1283.49	6.55	1276.94
NA186S	9/26/16	1283.49	6.15	1277.34
NA186S	11/7/16	1283.49	6.29	1277.20
NA186S	12/5/16	1283.49	5.99	1277.50
NA186S	2/13/17	1283.49	6.10	1277.39
NA186S	4/24/17	1283.49	5.89	1277.60
NA186S	6/5/17	1283.49	6.52	1276.97
NA186S	7/27/17	1283.49	6.33	1277.16
NA187D	7/1/15	1313.40	34.89	1278.51
NA187D	2/25/16	1313.40	35.87	1277.53
NA187D	7/1/16	1313.40	36.23	1277.17
NA187D	7/28/16	1313.40	34.57	1278.83
NA187D	9/26/16	1313.40	34.48	1278.92
NA187D	11/7/16	1313.40	34.84	1278.56
NA187D	12/5/16	1313.40	34.66	1278.74
NA187D	2/13/17	1313.40	38.58	1274.82
NA187D	4/24/17	1313.40	34.33	1279.07
NA187D	6/5/17	1313.40	34.40	1279.00
NA187D	7/27/17	1313.40	36.95	1276.45
NA187S	7/1/15	1313.25	20.35	1292.90
NA187S	2/25/16	1313.25	19.98	1293.27
NA187S	7/1/16	1313.25	18.90	1294.35
NA187S	7/27/17	1313.25	20.29	1292.96
NA69	4/1/15	1315.23	18.85	1296.38
NA69	7/1/15	1315.23	18.70	1296.53
NA69	10/1/15	1315.23	18.94	1296.29
NA69	2/25/16	1315.23	19.54	1295.69
NA69	4/1/16	1315.23	19.14	1296.09
NA69	7/1/16	1315.23	18.55	1296.68
NA69	10/1/16	1315.23	18.05	1297.18
NA69	4/1/17	1315.23	17.73	1297.50
NA69	7/27/17	1315.23	17.02	1298.21
NDM11	4/1/15	1292.82	13.33	1279.49
NDM11	7/1/15	1292.82	13.24	1279.58
NDM11	10/1/15	1292.82	13.33	1279.49
NDM11	2/25/16	1292.82	13.34	1279.48
NDM11	2/26/16	1292.82	13.34	1279.48
NDM11	4/1/16	1292.82	12.92	1279.90
NDM11	7/1/16	1292.82	12.90	1279.92

Table 2
Water Elevation Data in Monitoring Wells

Location	Date	TOC Elevation (feet NGVD)	Depth to Groundwater (feet)	Groundwater Elevation (feet NGVD)
NDM11	10/1/16	1292.82	12.80	1280.02
NDM11	4/1/17	1292.82	12.39	1280.43
NDM11	7/27/17	1292.82	12.80	1280.02
NDM15	4/1/15	1307.23	28.35	1278.88
NDM15	7/1/15	1307.23	27.84	1279.39
NDM15	10/1/15	1307.23	28.06	1279.17
NDM15	2/25/16	1307.23	28.33	1278.90
NDM15	2/26/16	1307.23	28.33	1278.90
NDM15	4/1/16	1307.23	27.78	1279.45
NDM15	7/1/16	1307.23	27.54	1279.69
NDM15	10/1/16	1307.23	27.50	1279.73
NDM15	4/1/17	1307.23	12.39	1294.84
NDM15	7/27/17	1307.23	27.48	1279.75
NDM24D	4/1/15	1295.74	20.51	1275.23
NDM24D	7/1/15	1295.74	20.08	1275.66
NDM24D	10/1/15	1295.74	20.18	1275.56
NDM24D	2/25/16	1295.74	20.71	1275.03
NDM24D	2/26/16	1295.74	20.71	1275.03
NDM24D	4/1/16	1295.74	19.62	1276.12
NDM24D	7/1/16	1295.74	19.85	1275.89
NDM24D	10/1/16	1295.74	21.00	1274.74
NDM24D	4/1/17	1295.74	20.42	1275.32
NDM24D	7/27/17	1295.74	20.77	1274.97
NDM24S	4/1/15	1296.39	9.79	1286.60
NDM24S	7/1/15	1296.39	9.25	1287.14
NDM24S	10/1/15	1296.39	DRY	
NDM24S	2/25/16	1296.39	8.27	1288.12
NDM24S	2/26/16	1296.39	8.27	1288.12
NDM24S	4/1/16	1296.39	6.84	1289.55
NDM24S	7/1/16	1296.39	8.55	1287.84
NDM24S	10/1/16	1296.39	DRY	
NDM24S	4/1/17	1296.39	6.55	1289.84
NDM24S	7/27/17	1296.39	DRY	
NHZ1D	2/26/16	1314.30	26.94	1287.36
NHZ1S	4/1/15	1310.56	13.20	1297.36
NHZ1S	7/1/15	1310.56	10.37	1300.19
NHZ1S	10/1/15	1310.56	11.77	1298.79
NHZ1S	2/26/16	1310.56	11.50	1299.06
NHZ1S	4/1/16	1310.56	9.40	1301.16
NHZ1S	7/1/16	1310.56	9.93	1300.63
NHZ1S	10/1/16	1310.56	11.22	1299.34
NHZ1S	4/1/17	1310.56	9.59	1300.97
NHZ1S	7/27/17	1310.56	10.00	1300.56

Figures

Bass Lake
2
Blackwater Creek
88
Unit 4
Surface Impoundment
2
Existing
CCR Landfill
Unit 3
Surface Impoundment
6
Bottom Ash
Surface Impoundment
Cohasset
87
Closed Fly Ash Pond
Old Bottom Ash
Surface Impoundment
Boswell
Energy
Center
Blackwater
Lake
Jay Gould
Lake
Mississippi River
Existing CCR Landfill
Extent
0
500
1,000
1,500
2,000
Feet
Imagery: FSA NAIP 2019
SITE LOCATION
Boswell Energy Center
Minnesota Power
Cohasset, MN
FIGURE 1
BARR

WELLS AND BORINGS
FOR DATA ANALYSIS
Boswell Energy Center
Minnesota Power

FIGURE 2


CROSS-SECTION
LOCATION MAP
Boswell Energy Center
Minnesota Power
FIGURE 3
Boring (2017)
Boring
APK series (2015-16)
CCR Monitoring Well
A series
HZ and DM series
B series
Geologic Cross-section Location
0
1,000
2,000
Feet
USDA NAIP Imagery Circa 2019
BARR
BW-2S
BW-3D
H-H'
I-I'
H
I
A-A'
A
A'
B-B'
B
B'
C-C'
C
C'
D-D'
D
D'
E-E'
E
E'
J'
F-F'
F
F'
G-G'
G
G'
H'
I'
J-J'
J
BW-1S
NA-183D
NA187D
A187S
NA181D
A192D
A180D
A174D
A191D
A188D
A194S
NA184D
A190D
NA1D
NA186S
A178D
A189D
NA-193D
DB-1
DB-2
DB-3
DB-4
B-1-11
B-2-11
B-3-11
B-4-11
B-5-11
B-6-11
APK-1
APK-2
APK-3
APK-4
APK-5
APK-6
APK-7
APK-8
APK-9
APK-10
APK-11
APK-12
C-A28
C-A71
C-AP5
GP-1
GP-1A
GP-2
GP-3
GP-4
GP-5
DM-1
DM-2
DM-3
DM-4
DM-5
DM-7
DM-8
DM-9
DM-10
DM-11
DM-12
DM-13
DM-14
DM-15
DM-16
DM-17
DM-18
DM-19
DM-21
DM-22
DM-24
HZ-2
HZ-3
HZ-4
HZ-9
HZ-10
HZ-11
HZ-13
HZ-15
HZ-16
HZ-17